ORDER

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

8260.44

10/20/97

SUBJ: **Civil Utilization of Area Navigation (RNAV) Departure Procedures**

1. PURPOSE. This order, in conjunction with Order 8260.3B, United States Standard for Terminal Instrument Procedures (TERPS), and Order 8260.38A, Civil Utilization of Global Positioning System (GPS), provides criteria for constructing instrument flight rules (IFR) RNAV departure procedures.

2. DISTRIBUTION. This order is distributed in Washington Headquarters to the director level of the Air Traffic Service; the Offices of Airport Safety and Standards, and Communications, Navigation, and Surveillance Systems; to the division level in the Flight Standards Service; and to the National Flight Procedures Office; to the Regulatory Standards and Compliance Division at the Mike Monroney Aeronautical Center; and to the regional Flight Standards divisions.

3. DEFINITIONS.

a. Baseline. A line, perpendicular to the course line at the latest position of the fix displacement tolerance area, used for construction of turn area expansion arcs.

b. Climb-in-hold (CIH). Climbing in holding pattern.

c. Departure Altitude. The departure altitude is an altitude at the end of the departure evaluation area which satisfies the requirements for en route operations. This term is similar in concept to the "missed approach altitude."

d. Departure End of Runway (DER). The end of runway declared available for the ground run of an aircraft departure.

e. Distance of Turn Anticipation (DTA). A distance preceding a waypoint (WP) at which an aircraft is expected to start a turn to intercept the course of the next segment.

f. Fly-By Waypoint. A waypoint where turns are initiated prior to reaching it.

g. Fly-Over Waypoint. A waypoint over which an aircraft is expected to fly before the turn is initiated.

Distribution: A-W(AT/AS/ND)-1; A-W(FS)-2; AVN-100 (100 cys); AMA-200 (80 cys); A-X(FS)-2

Initiated By: AFS-400

FAA Form 1320-1 (6-80)

* U.S. GPO: 1992-668-634

h. Initial Climb Area. That portion of the departure within 2 NM of the DER.

i. Minimum Crossing Altitude (MCA).

j. Minimum En Route Altitude (MEA).

k. Obstacle Clearance Surface (OCS). A surface which obstacle penetrations are not allowed.

l. Reference Line. A line parallel to the course line, following a turn waypoint (TWP), used to construct a second set of expansion arcs.

m. Reference Waypoint. A point of known location used to geodetically compute the location of another WP.

n. Required Navigation Performance (RNP). A statement of the navigation performance accuracy necessary for operation within a defined airspace. For TERPS purposes, terminal RNP operations defined as RNP-1, meet the requirements for primary area width of +/- 2 NM.

o. Turn Anticipation.. The capability of RNAV airborne equipment to determine and enunciate to the pilot the location of the point along a course, prior to a TWP, where a turn should be initiated to provide a smooth path to intercept the succeeding course.

SECTION 1. GENERAL CRITERIA

4. GENERAL. These criteria establish design standards for development of RNAV instrument departure procedures. Procedures designed using these criteria will be annotated for use by aircraft with GPS RNAV capability or RNP certification which reflects required navigational performance capabilities. See paragraph 6.

a. Climb to an Altitude. Criteria for "climb to an altitude and turn" is not provided.

b. Waypoint Substitution. Existing fixes/navigational aids (NAVAIDS) may be substituted for an RNAV WP where conveniently located. For purposes of simplicity in these criteria, the term WP will be used to denote a fix.

c. Fix Displacement Area. Terminal RNAV fix displacement tolerance applies where the plotted position of the WP is at, or within, 30 nautical miles (NM) straight line measurement of the departure airport's reference point (ARP). En route fix displacement applies beyond 30 NM from the ARP. See table 1. Apply en route fix displacement tolerance for all waypoints after the course crosses the 30-NM-point from ARP, including succeeding waypoints that may lie within 30 NM of the ARP, should the route return into the area.

TABLE 1

	FIX DISPLACEMENT TOLERANCE	
	EN ROUTE	TERMINAL
XTRK	2.8	1.5
ATRK	2	1

d. Waypoints. "Fly-by waypoints" are preferred in all situations. Use "fly-over waypoints" **only** when an operational advantage is achieved. Document the fix use and status of a waypoint as "fly-by" or "fly-over" in the REMARKS block of FAA Form 8260-2, Radio Fix and Holding Data Record, under fix use. Establish WP's to designate route course changes and altitude restrictions/changes.

e. Charting Instructions. All RNAV departures shall be charted graphically.

f. Waypoint Definition. For departure WP's located on runway centerline extended, establish coordinates using the reciprocal of the opposite direction runway true bearing and the appropriate distance applied from the DER. Where two or more segments are aligned along a continuous geodetic line, align and construct all succeeding WP's based on a true bearing and distance from the first (reference point) in the sequence. Where turns are established, use the TWP as the reference WP to construct succeeding WP's and segments aligned on a continuous geodetic line following the turn.

g. Course Change at Waypoints. The departure course at a WP is the bearing from that WP to the following WP. The arrival course at the WP is the reciprocal of the course from that WP to the preceding WP. The difference between the departure course and the arrival course at a WP equals the amount of turn at that WP. Maximum course change allowable is 120°.

5. IDENTIFICATION OF RNAV INSTRUMENT DEPARTURE PROCEDURES. Identify the procedure as "RNAV DEPARTURE" followed by the takeoff runway number; e.g., RNAV DEPARTURE RWY 27. Multiple departure procedures from the same runway must identify a geographical route or use a transitional route name; e.g., BRAXTON FOUR RNAV DEPARTURE, or RNAV DEPARTURE, RWY 27, LEMHI TRANSITION.

6. ROUTE DESCRIPTION. Specify the magnetic courses using the magnetic variation of the departure airport until the departure route joins the en route airway system. Include the names of all WP's or fixes in the order flown with any turns or altitude crossing requirements specified at these points. Preface the route description with "RNP-1.0 or GPS required. Select 1 NM receiver sensitivity, if available."

7. APPLICATION.

a. Apply diverse departure criteria contained in Order 8260.3B, chapter 12, to determine if RNAV departure routes are required.

b. Aircraft Departure Outer Boundary Radius. See table 2.

(1) When the first TWP is within 6 NM of DER, use an outer boundary radius of 2 NM for that area; for any turns thereafter, apply paragraphs 7b(2) or (3) as appropriate.

(2) For all turns below 10,000 feet mean sea level (MSL), use 250 knots indicated airspeed (KIAS) unless a speed restriction of 200 KIAS is noted on the procedure for that turn.

(3) For turns at 10,000 feet MSL and above, use 310 KIAS, unless a speed restriction of 200 or 250 KIAS is noted on the procedure for that turn.

(4) Where 200 or 250 KIAS is required, publish a speed restriction. Example: "Do not exceed (200/250) KIAS," or "Do not exceed (200/250) KIAS until CHUCK WP."

(5) When speeds above 250 KIAS are authorized below 10,000 feet MSL or above 310 KIAS, 10,000 feet MSL and above, use the 310 or 350 columns in table 2 as appropriate.

8. AREA.

a. Initial Climb Area. (See appendix 1, figure 1.)

(1) All departures must proceed along runway centerline extended during the initial climb to a specified point past DER. Locate the first WP after DER on extended runway centerline at a sufficient distance from DER to allow the aircraft to climb to at least 400 feet above airport elevation. The minimum distance allowable for fly-by WP's is 2 NM or the DTA distance measured from the beginning of the fix displacement tolerance area. A shorter distance up to 1 NM is allowed for a fly-over WP published with a climb gradient. (See appendix 1, figure 1.) Also, where the 400 feet above airport elevation requirement is not achieved for the first WP, publish a climb gradient. (See paragraph 12a.)

(2) Initial Segment Width. (See appendix 1, figure 2.) From a point 500 feet each side of runway centerline:

(a) Splay the area at 7.5°, angular with the course line, until it reaches the width of the primary area, or the departure terminates, whichever occurs first. Where a turn occurs prior to the initial segment completing 2 NM primary width each side of centerline, refer to instructions in paragraph 9a(8).

(b) From the same point, splay a line at 15°, angular with the course line, until it reaches a distance of 1 mile from the primary area boundary. This defines the secondary area width.

b. Departure Route Segments.

(1) Length. Segment length is measured between plotted positions of the WP's. Except for the initial climb area, the length of a segment shall be sufficient to encompass all turn anticipation and outside turn expansion requirements. The minimum segment length:

(a) In the case of two successive fly-by turning WP's, is the DTA and the ATRK fix displacement tolerance of the first waypoint plus DTA including the ATRK fix displacement tolerance of the second waypoint. (See figure 1 and appendix 1, figure 3, for the areas.)

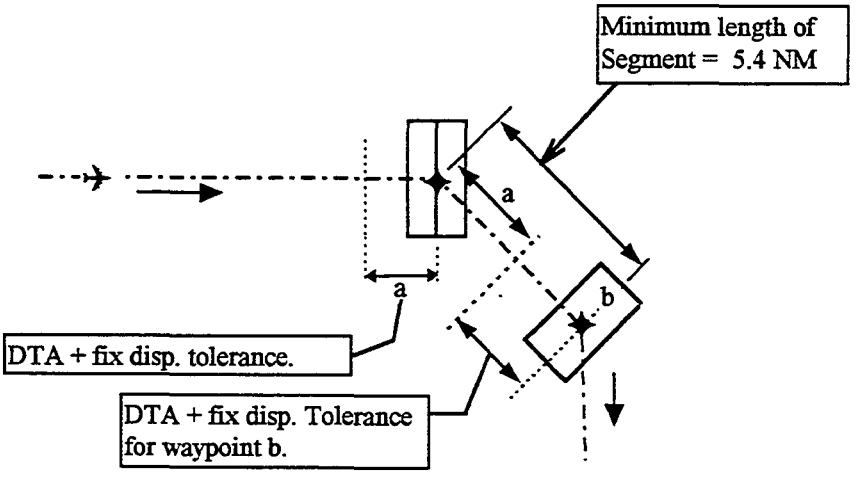


Figure 1

Example steps of computation:

Given:

Aircraft Speed: 250 KIAS

Altitude: Below 10,000' MSL

First turn angle: 45°

Second turn angle: 45°

Within 30 NM of ARP

Step 1. Determine the outer boundary radius of first turn from table 2:

4.2 NM

Step 2. Determine DTA of first turn:

DTA = 4.2 × Tangent (45°÷2) = 4.2 × .41 = 1.7 NM

Step 3. Add fix displacement tolerance: 1.7 + 1 = 2.7 NM

Step 4. Compute the DTA of the second turn waypoint plus fix displacement tolerance: 2.7 NM

Step 5. Compute the minimum segment length by adding the two dimensions derived in steps 1 through 4:

Minimum Length of Segment = 2.7 + 2.7 = 5.4 NM

(b) In the case of two successive fly-over WP's, see figure 2 and appendix 1, figure 4, for the areas, use the following formula:

$$X = r[2 + \sin\theta - 1.732\cos\theta]$$

Where: X = distance from the first TWP to the ATRK fix displacement tolerance of the second TWP.
r = R1, table 2.
θ = angle of turn

Determine the fix displacement tolerance from table 1 and add this dimension to X to obtain the total distance between the TWP's.

Example steps of computation:

Given:

Aircraft speed: 250 KIAS

Altitude: Below 10,000' MSL

First turn angle: 45°

Second turn angle: (not applicable)

First TWP within 30 NM of ARP

Step 1.

$X = 4.2[2 + \sin 45 - 1.732\cos 45] = 6.2$ NM

Step 2. Determine the fix displacement tolerance of the second TWP from table 1.

Step 3. Add the two dimensions calculated in steps 1 and 2:

X + fix displacement tolerance = 6.2 + 1 = 7.2 NM.

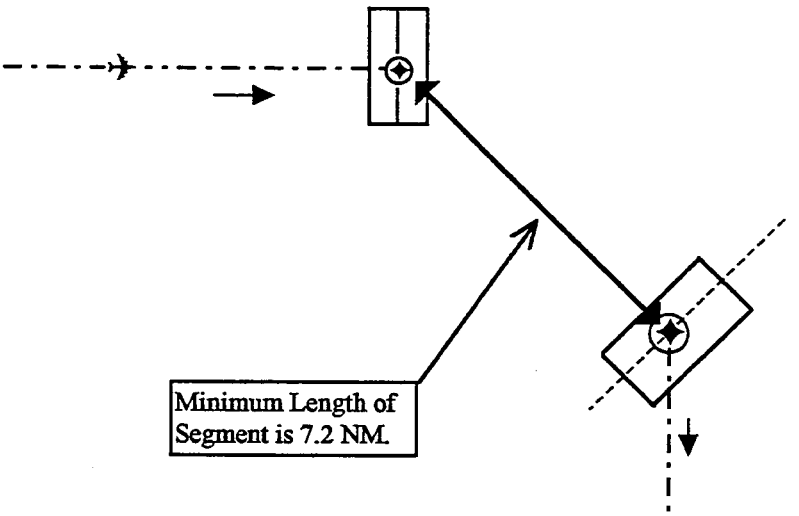


Figure 2

Minimum length of segment = 7.2 NM. (See figure 2)

(c) From a fly-by to a fly-over WP, is the DTA plus the ATRK fix displacement tolerance of the first WP, and the ATRK fix displacement tolerance of the second WP. See figure 3 and appendix 1, figure 5, for the areas.

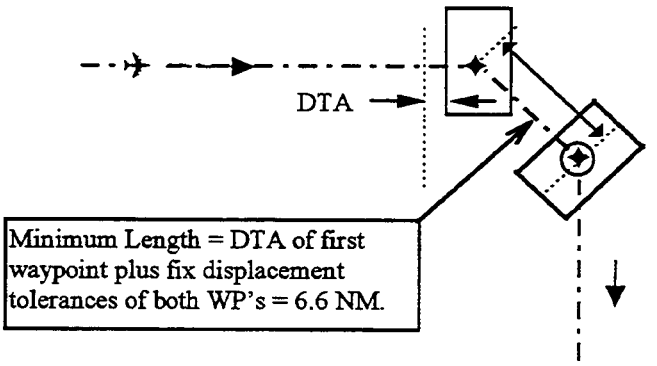


Figure 3

Example steps of computation:

Given:

Aircraft Speed: 250 KIAS

First turn angle: 50°

Altitude: More than 10,000' MSL

Segment more than 30 NM from ARP.

Step 1. Determine the turning radius of first turn from table 2: 5.5 NM

Step 2. Determine DTA of first turn:

DTA = 5.5 × Tangent (50°÷2) = **2.6 NM**

Step 3. Add the DTA derived in step 2 plus the fix displacement tolerances (en route) of both WP's:

Minimum Length of Segment = 2.6 + 2.0 + 2.0= 6.6 NM

(d) From a fly-over to a fly-by WP, use the following formula, see figure 4 and appendix 1, figure 6, for the areas: $X = r\left[2 + \sin\theta - 1.732\ \cos\theta\right]$

Where: X = distance from the first TWP to the DTA point of the second TWP.

r = R1, table 2

θ = angle of turn

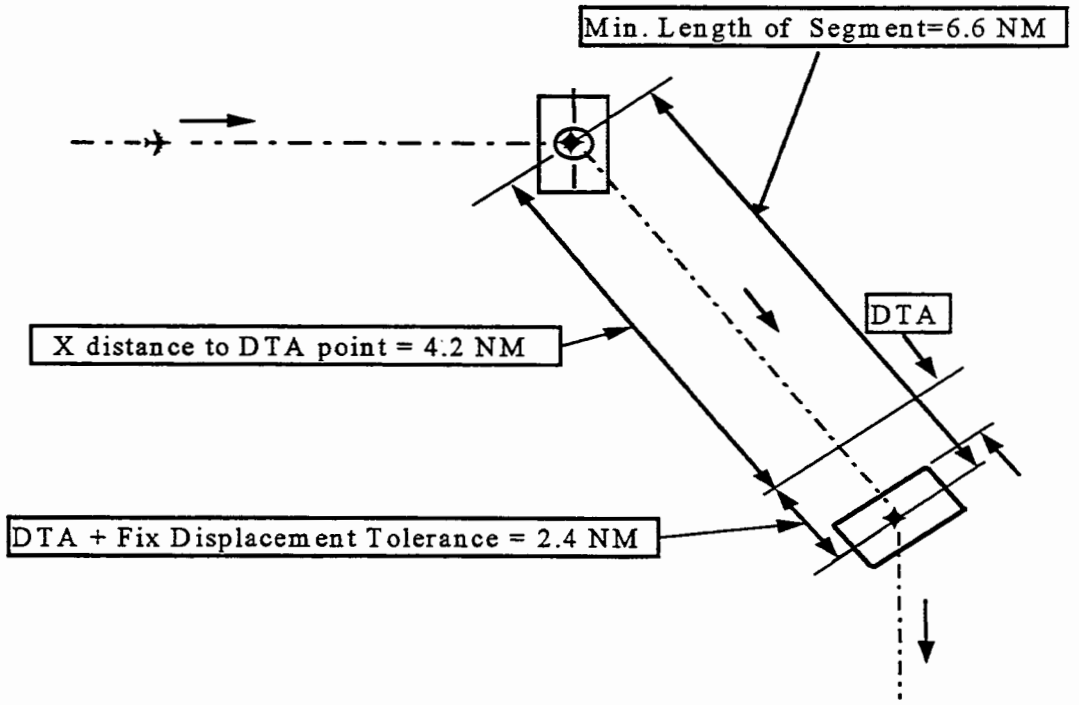


Figure 4

Example steps of computation:

Given:

Aircraft Speed: 200 KIAS

First turn angle: 35°

Second turn angle: 50°

Altitude: Below 10,000' MSL

Segment less than 30 NM from ARP.

Step 1.

$X = 2.9\,[2 + \sin 35° - 1.732 \cos 50] = 4.2$ NM

Step 2. Determine R1 of second turn from table 2: 2.9 NM

Step 3. Determine DTA of second turn:

DTA = 2.9 × Tangent (50°÷2) = 2.9 × 0.46 = 1.4 NM

Step 4. Add fix displacement tolerance:

1.0 + 1.4 = 2.4 NM

Step 5. Determine minimum total distance between waypoints by adding the dimension in step 2 to the dimension in step 4:

Total distance waypoint to waypoint =
Minimum length of segment = 4.2 + 2.4 = 6.6 NM. (See figure 4)

(2) Width.

(a) Within 30 NM from the ARP. (See appendix 1, figure 7.)

1 Primary Area: 2 miles on each side of the segment centerline.

2 Secondary Area: 1 mile on each side of the primary area.

(b) Beyond 30 NM from the ARP. (See appendix 1, figure 8.)

1 Primary Area: 3 miles on each side of the segment centerline.

2 Secondary Area: 3 miles on each side of the primary area.

(c) Once the departure segment expands to the respective primary and secondary area widths, the area widths remain constant, except for turn expansion areas, until reaching 30 NM from ARP, or the en route structure, whichever occurs first. See paragraph 14. At the 30 NM point from the ARP, the areas splay to the dimensions stated in paragraph 8b(2)(b), use the primary area 30° splay method. Using this method the secondary area splay lines begin and end abeam their corresponding primary area splay lines. Once the

area expands to the 3/3 width, it remains that width until reaching the en route structure. (See appendix 1, figure 7.)

(d) Crosstrack fix displacement tolerances need not be considered in the construction of the 7.5°, 15°, and 30° splay areas, with regard to possible overlap of the splay boundary.

c. Departure areas merging with en route airway structure.

(1) Fly-by WP's.

(a) When the departure merges with an airway and departure areas are 2 and 1 NM primary and secondary respectively, the areas do not require any turn expansion. (See appendix 1, figure 9.)

(b) When the departure merges with an airway and the departure areas are 3 and 3 NM primary and secondary respectively, they require inside turn expansion. (See appendix 1, figure 10.)

(c) When the departure merges with an airway and departure areas are splaying from 2 and 1 NM areas to 3 and 3 primary and secondary areas respectively, the splay of the outside boundary ends where the two courses intersect. Inside expansion is not required. (See appendix 1, figure 11.)

(2) Fly-over WP's. When the departure area merges with an airway, outside turn expansion is required for all departure areas; i.e., 2 and 1 NM or 3 and 3 NM, primary and secondary areas. (See appendix 1, figure 12.)

9. TURN AREA EXPANSION. For turns greater than 15°, an expansion of the departure area is required. Provide inside expansion area for fly-by WP's. (See appendix 1, figures 13 through 15.) Outside expansion is not required for fly-by WP's. Establish outside expansion areas for fly-over WP's. (See appendix 1, figures 16 through 18.) Inside expansion is not required for fly-over WP's.

a. Outside Expansion Area for a fly-over WP.

(1) Construct a line perpendicular to the course centerline at the latest point of the displacement tolerance of the TWP. This line, C'-A-B, is the baseline for constructing a set of arcs to establish boundaries of the outside expansion areas. (See appendix 1, figures 4 through 8 and 8 through 16.)

(2) Locate point C at a distance of R1 from edge of the primary area along a base line. Using point C on the baseline as a center point, draw an arc with radius R1 on the outside edge of the primary area of the turn. (R1 is a boundary radius selected from table 2.) Draw a

second arc with radius R2, using point C as a center point, from the outer edge of the secondary area on the outside of the turn. (See table 2 and appendix 1, figure 16.)

Table 2

Primary Area Outer Boundary radius (R1)				
Aircraft Speed (KIAS)	180	250	310	350
Below 10,000' MSL Radius (R1) (NM)	2.5	4.2	6	7.3
10,000' MSL and Above Radius (R1) (NM)	3.4	5.5	7.7	9.3
R2 is R1 plus (1 NM or 3 NM) of secondary width, whichever applies.				

(3) To determine the elevation for application of table 1, use the flight track distance to the WP applying the 200-feet per mile and/or published climb gradient where applicable.

(4) Point D:

(a) For turns 90° or greater locate point D, on the baseline at a distance R1 from point C. (See appendix 1, figures 16 through 18.)

(b) For turns less than 90°, construct a reference line parallel to the line following the TWP. Locate point D on the reference line at a distance R1 from C1. (See appendix 1, figure 4.)

(5) Using point D as a center point, draw two arcs with radius R1 and R2, respectively. Radius R1 and R2 arcs define the primary and secondary expansion areas, respectively. Connect arcs with tangent lines. (See appendix 1, figure 4.)

(6) Locate C1 in same manner as in paragraph 9a(2). Construct a line on the outside of the turn, parallel to the course line, offset by a distance ½ the segment width. Locate E2 at the intersection of this line and the base line of this segment. Locate C2, a distance of R1 from E2. Using C2 as a center point, draw arcs R1 and R2. Connect, via tangents, the arcs centered at C1, D, C2 respectively. Connect the arcs centered at C2 to the primary and secondary boundaries of the succeeding segment. Use 30° tangent connecting lines relative to the succeeding course line when possible.

(7) The radius in table 2 applies also for the primary area boundary radius. Use the boundary radius for 250 KIAS.

(8) Expansion within the splay areas.

(a) Where a turn occurs prior to the splayed areas reaching the 2/1 primary/secondary widths, the same construction applies as in paragraph 9a(4) and (5); except, the primary arc R1 is drawn from the edge of the primary area, point C′, abeam the latest point of the displacement tolerance of the TWP. Draw the secondary arc of radius R2. Extend the secondary area splay (prior to turn) until it intersects the arc at point E. (See appendix 1, figure 17.)

(b) Where a turn occurs when the 2/1 NM primary/secondary areas to the 3/3 primary and secondary areas respectively occurs within the turn area expansion, a similar construction applies as in paragraph 9a(8)(a).

(c) Where the first WP is less than 2 NM beyond the DER, the inside turn boundary begins 500 feet abeam the DER. (See appendix 1, figure 18.)

b. Inside Expansion Area for a fly-by WP.

(1) Where turns occur during the initial splays, the width of the segment following the TWP begins at the same width the preceding segment ended and the splays continue as described in paragraph 8, except for turn expansion area indicated below.

(2) Locate a point on the primary area boundary on the inside of the turn, at the DTA. The DTA is measured parallel to the course back from the earliest point of the TWP's displacement area. The length of the DTA is determined by the following formula and it applies to turns of more than 15°: (See appendix 1, figure 14.)

$$DTA = R1 \times \tan(\text{turn angle} \div 2)$$ See table 2 for R1.

(3) When the obstacle clearance area boundaries of the segments preceding and following the WP are parallel with the course centerline, see appendix 1, figure 13:

(a) Expand the primary boundary area by an angle equal to one-half of the course change.

(b) Construct the secondary area boundary, parallel with the primary expansion boundary, using the width of the preceding segment secondary area.

(c) The resulting gap on the outside of the turn is closed by appropriate radii equal to the distance from the WP center to the edge of the primary or secondary abeam the TWP.

(4) When the DTA point prior to the WP occurs during the splaying of the obstacle clearance area boundaries, (i.e., inside the area where the splay is incomplete):

(a) Locate a point A′ on the edge of the primary area at the DTA distance, measured parallel to the course following the plotted position of the WP after completing the turn. Construct the primary boundary area by connecting point A with A′. (See appendix 1, figure 14.)

(b) Locate point B on the edge of the secondary area abeam point A. Locate point B′ on the edge of the secondary area abeam point A′. Construct the secondary area boundary by connecting point B with B′. (See appendix 1, figure 14.)

(c) For turns less than or equal to 75°, the resulting gap on the outside boundaries of the turn is closed by appropriate radii equal to the distance from the plotted position of the TWP to the edge of the primary or secondary area abeam the TWP. (See appendix 1, figure 14.)

(d) For turns greater than 75°, after the turn, locate A′ on edge of primary area at the DTA distance measured from the latest point of the fix displacement area. The resulting gap on the outside boundaries of the turn is closed by radii equal to 2 NM for the primary area and 3 NM for the secondary. The succeeding segment's primary and secondary area boundary on the outside of the turn expand to 2 NM and 1 NM respectively. When the width of the primary area at the TWP has not reached 2 NM, extend the primary and secondary boundaries of the preceding segment beyond the TWP until the primary area boundary intersects a 2 NM arc centered on the TWP. Continue the secondary area boundary until it intersects a 3 NM arc centered on the TWP. (See appendix 1, figure 15.)

10. DEPARTURE ALTITUDE. Establish a departure altitude which is the highest altitude of:

a. Joining an existing airway:

(1) A level surface evaluation. See paragraph 11f.

(2) The appropriate MEA or MCA for the direction of flight.

b. Off airway termination:

(1) A level surface evaluation.

(2) Altitude where radar service can be provided.

c. An air traffic control requirement.

11. OBSTACLE EVALUATION. The area considered for obstacle evaluation begins at the beginning of the departure area, and ends at a point or a WP/fix/NAVAID defining the end of the departure. See paragraph 13. The maximum required obstacle clearance (ROC) for level flight is 1,000 feet in non-mountainous areas and 2,000 feet in designated mountainous areas,

except when Order 8260.3B, paragraph 1720, is applied. Do not compute a climb gradient above an altitude which satisfies these ROC's.

a. Primary Area. No obstacle shall penetrate a 40:1 OCS which begins at the DER no higher than 35 feet above DER elevation and rises in the direction of flight. The OCS rises along the shortest distance in the primary area from its beginning to the obstacle. For turns, evaluate obstacles on the turning side of the initial climb area by measuring back, within the primary area, the shortest distance to the beginning of the departure area. (See appendix 1, figures 2 and 19.)

b. Secondary Area. No obstacle shall penetrate a 12:1 OCS which rises from the edge of the primary area perpendicular to the segment course. In a turn expansion area, the 12:1 OCS rises perpendicular to the edge of the primary area. (See appendix 1, figures 2 and 19.) Determine the height of an equivalent obstacle on the edge of the primary area, then evaluate the equivalent obstacle relative to the 40:1 OCS at that point.

Example: A 9,840' MSL obstacle is located in the secondary area, 2,700' from the edge of the primary area.

Step 1. Determine the elevation of an equivalent obstacle (E_E) on the edge of the primary area:

Rise of 12:1 slope to edge of primary area:	$\frac{2,700'}{12} = 225'$
Elevation of obstacle (E_O)	9,840'
Less 12:1 rise	- 225'
E_E	9,615'

Step 2. Determine the 40:1 OCS elevation at equivalent obstacle:

D = distance (NM) from beginning of departure area measured along the shortest distance within the primary area = 21,344' = 3.513 NM

Plus 40:1 rise:	$\frac{21,344'}{40} = 533.6'$
DER elevation	7,640.0'
40:1 rise	+ 533.6'
40:1 OCS elevation at equivalent obstacle	8,173.6'

c. When the departure joins an en route airway, normally the departure area ends at the point where the departure course and the en route course intersect. Where the standard climb gradient (200 feet/NM), allows the aircraft to reach the MEA/MCA, further evaluation of the OCS beyond the intersection is not required. Where the standard climb gradient does not allow the aircraft to reach the MEA/MCA, continue the OCS evaluation as necessary to the point where the height of the OCS equals the lowest MEA for all directions of flight minus applicable en route ROC.

d. Where penetrations of the OCS in paragraph 11c occur:

(1) Provide a CIH evaluation to the MEA, see paragraph 13, at the departure/airway intersect point (preferred holding pattern alignment is on the airway); or

(2) Provide a climb gradient to MEA at the departure/airway intersect point; or

(3) If during a CIH evaluation an OCS penetration occurs, establish a climb gradient as necessary to clear offending obstacles.

e. Where the standard climb gradient will not allow the aircraft to comply with an airway MCA, provide a note indicating climb gradient required. For example: Departures north bound on Victor 240 require a minimum climb of 426 feet/NM to 7,300 feet.

f. The OCS height where the departure course and en route segment intersect is determined by measuring the shortest distance within the primary area to a line drawn perpendicular to the departure course through the point of intersection defined by a WP/fix/NAVAID.

g. Apply a level surface evaluation for the entire departure in a similar manner as stated in paragraphs 274 and 277, Order 8260.3B.

12. CLIMB GRADIENTS.

a. For the initial climb area, where distance to first WP is less within 2 NM, calculate a climb gradient to the first WP using the following formula:

$$G = \frac{(APT + 400') - DERELEV}{D_I}$$

Where: G = climb gradient (feet/NM)

APT = airport elevation

DERELEV = DER elevation

D_I = distance (NM) from DER measured along the route centerline

NOTE: The 400′ value may be increased by operational/air traffic requirements.

Example: Airport elevation = 3,000′

DER elevation = 2,950′

The first WP is located 1.6 NM beyond the DER

$$\frac{(3{,}000'+400)-2{,}950'}{1.6} = 281'$$

b. For any segment, including the initial climb area, avoid obstacles (including equivalent obstacles from paragraph 11b) which penetrate the OCS, by specifying a climb gradient that provides 48 feet/NM ROC not to exceed the maximum required obstacle clearance specified in paragraph 11 applied over distance (D). Apply the minimum climb gradient required for obstacle clearance. The minimum climb gradient for an obstacle is determined from the formula:

$$G = \frac{(48D) + H_O}{D}$$

Where: G = Climb Gradient (feet/NM)

H_O = Height (feet) of obstacle above DER (feet) or H_E as appropriate
D = Distance (NM) from DER measured along the shortest distance within the primary area

Example: Determine minimum climb gradient (G):

E_E	9,615'
DER elevation	-7,640'
Height (H_E) of equivalent obstruction above DER	1,975'

$$G = \frac{48D + H_E}{D}$$

$$G = \frac{48\,(3.51) + 1{,}975'}{3.51} = 610.7 = \underline{611 \text{ feet/NM}}$$

c. Specify the climb gradient to an altitude where a gradient greater than 200 feet/NM is no longer required. The climb gradient termination altitude (A_T) may be determined by the formula:

$$A_T = 48D + E_O$$ (round to the next higher 100-foot increment)

Where: E_O = Obstacle Elevation (MSL)

D = (as defined in paragraph 12b)

Example: Minimum climb gradient termination altitude (A_T):

$$A_T = 48D + E_E$$ (round to the next higher 100-foot increment)

[3.51 x 48] + 9,615' = 9,783.5' = 9,800' MSL

Using example in paragraph 12b: "------with a minimum climb of 610'/NM to 9,800'."

d. Multiple Climb Gradients. Where multiple climb gradients exist within a segment, (e.g., due to multiple obstacle clearances, and/or as well as air traffic control requirements, or to meet en route MCA requirements) publish the highest computed climb gradient for that segment.

e. Climb gradients based on an MCA or ATC requirements are calculated using flight track distance. Measurement is between DER and a point where an altitude is required, or WP/fix/NAVAID between OER or between WP's/fix's/NAVAID's as required.

Example: Flight track distance: 12 NM

altitude	8,000'
elev DER	-1,200'
	6,800'

$$G = \frac{6{,}800'}{12} = 566.66 \text{ round to nearest foot (567' per NM)}$$

G = climb gradient

13. CLIMB IN A HOLDING PATTERN. For a CIH, apply the criteria in paragraph 293b, Order 8260.3B, and paragraph 8, Order 8260.38A. (See appendix 1, figure 20.) Minimum holding shall be at an altitude where radar service can be provided or when joining an airway provides en route operations.

14. END OF DEPARTURE. The departure evaluation terminates at:

a. A WP/fix/NAVAID not on an en route structure:

(1) Where radar service can be provided.

(2) Where a CIH evaluation is required to reach an altitude where radar service can be provided.

b. An en route WP/fix/NAVAID from which the aircraft can continue en route operations.

SECTION 2. DIRECTIVE FEEDBACK INFORMATION

15. INFORMATION UPDATE. Forward for consideration any deficiencies found, clarification needed, or suggested improvements regarding the content of this order to:

DOT/FAA
ATTN: Flight Procedures Branch, AFS-440
P.O. Box 25082
Oklahoma City, OK 73125

a. Your Assistance is Welcome. FAA Form 1320-19, Directive Feedback Information, is included at the end of this order, for your convenience. If an interpretation is needed immediately, you may call the originating office for guidance. However, you should also use the FAA Form 1320-19 as a follow-up to the verbal conversation.

b. Use the "Other Comments" block of this form to provide a complete explanation of why the suggested change is necessary.

for Thomas E. Stuckey
Acting Director, Flight Standards Service

FIGURE 1. RNAV DEPARTURES, INITIAL CLIMB AREA, paragraph 8.

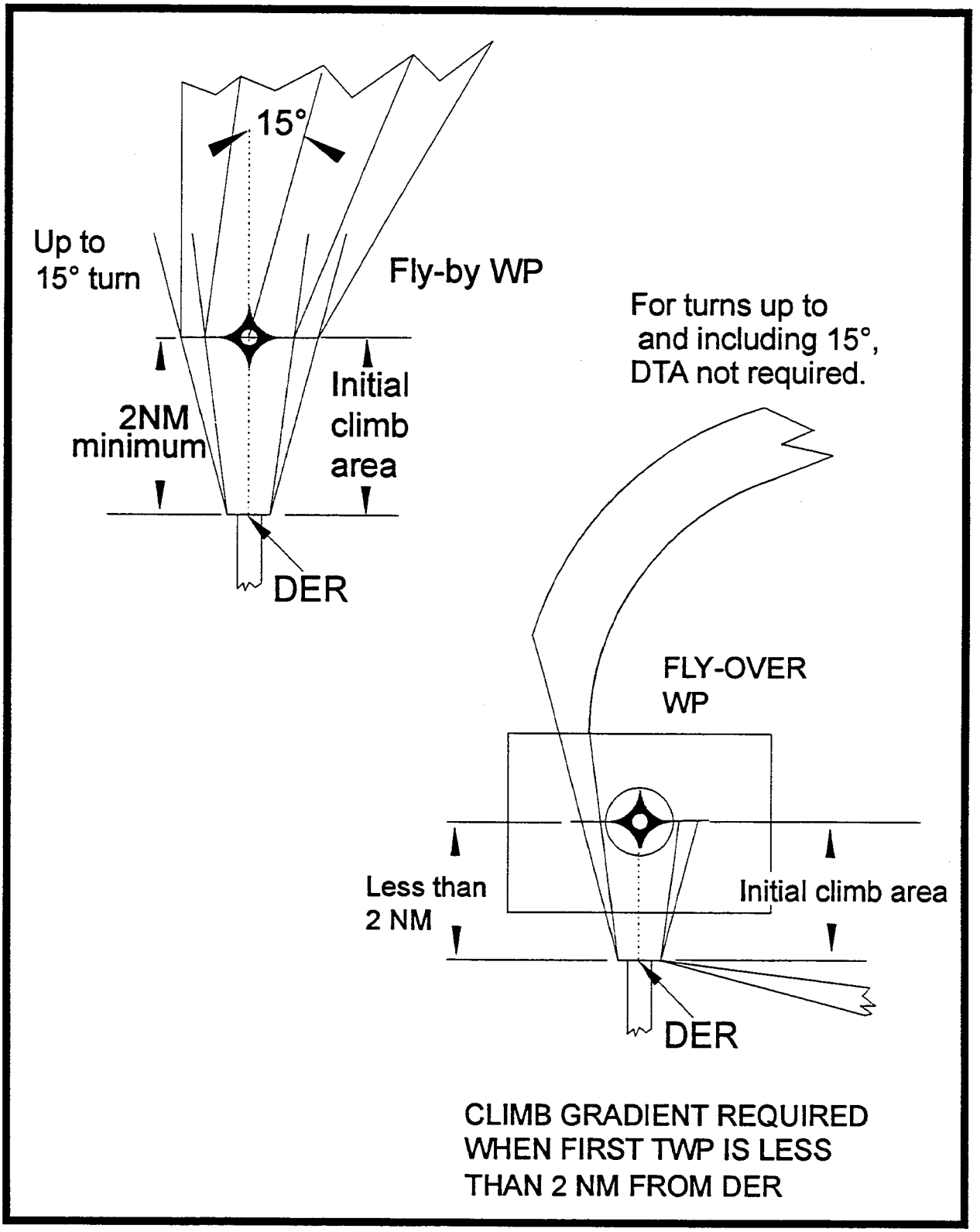


FIGURE 2. RNAV DEPARTURE, paragraph 8.

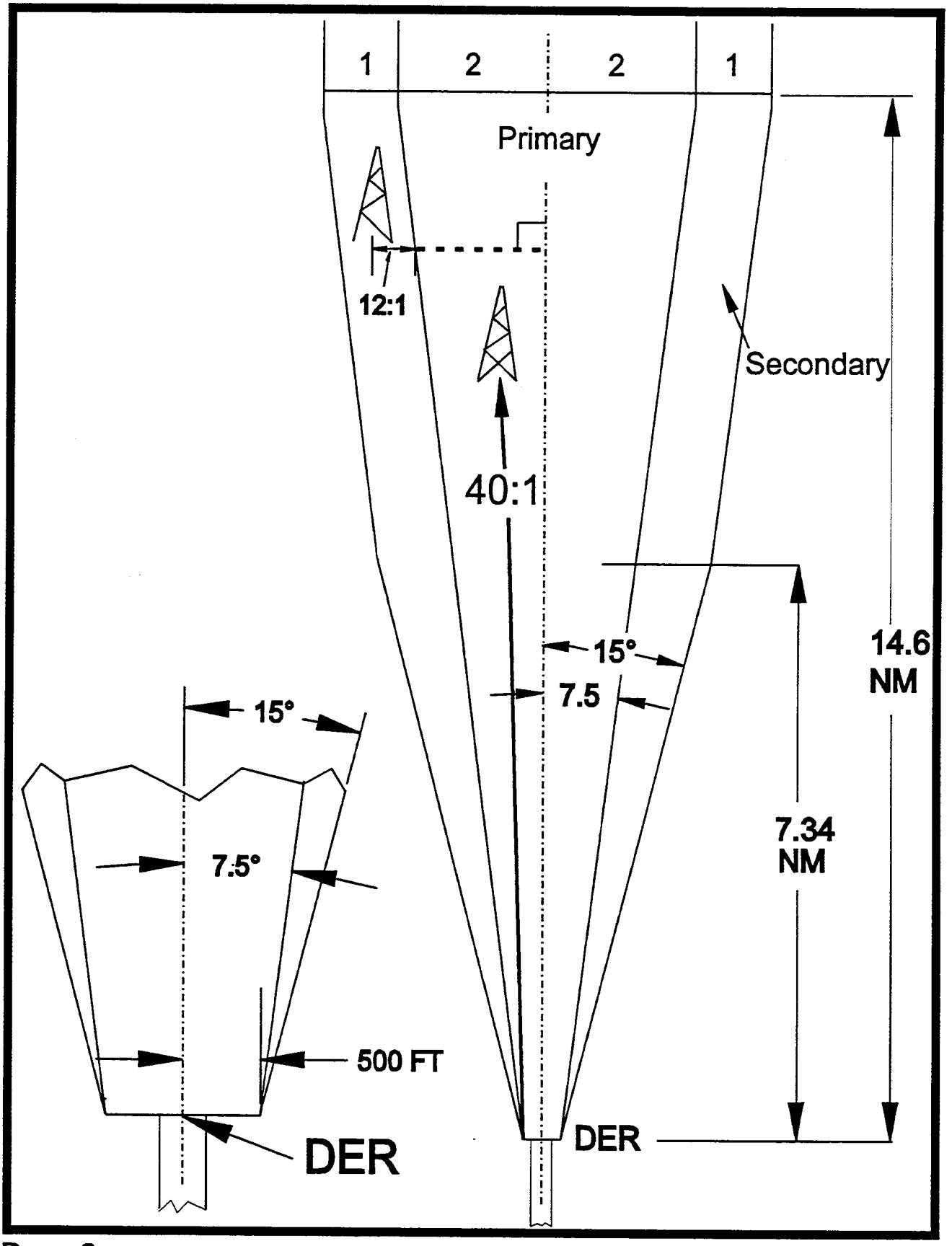


FIGURE 3. RNAV DEPARTURE, FLY-BY WP, paragraph 8b.

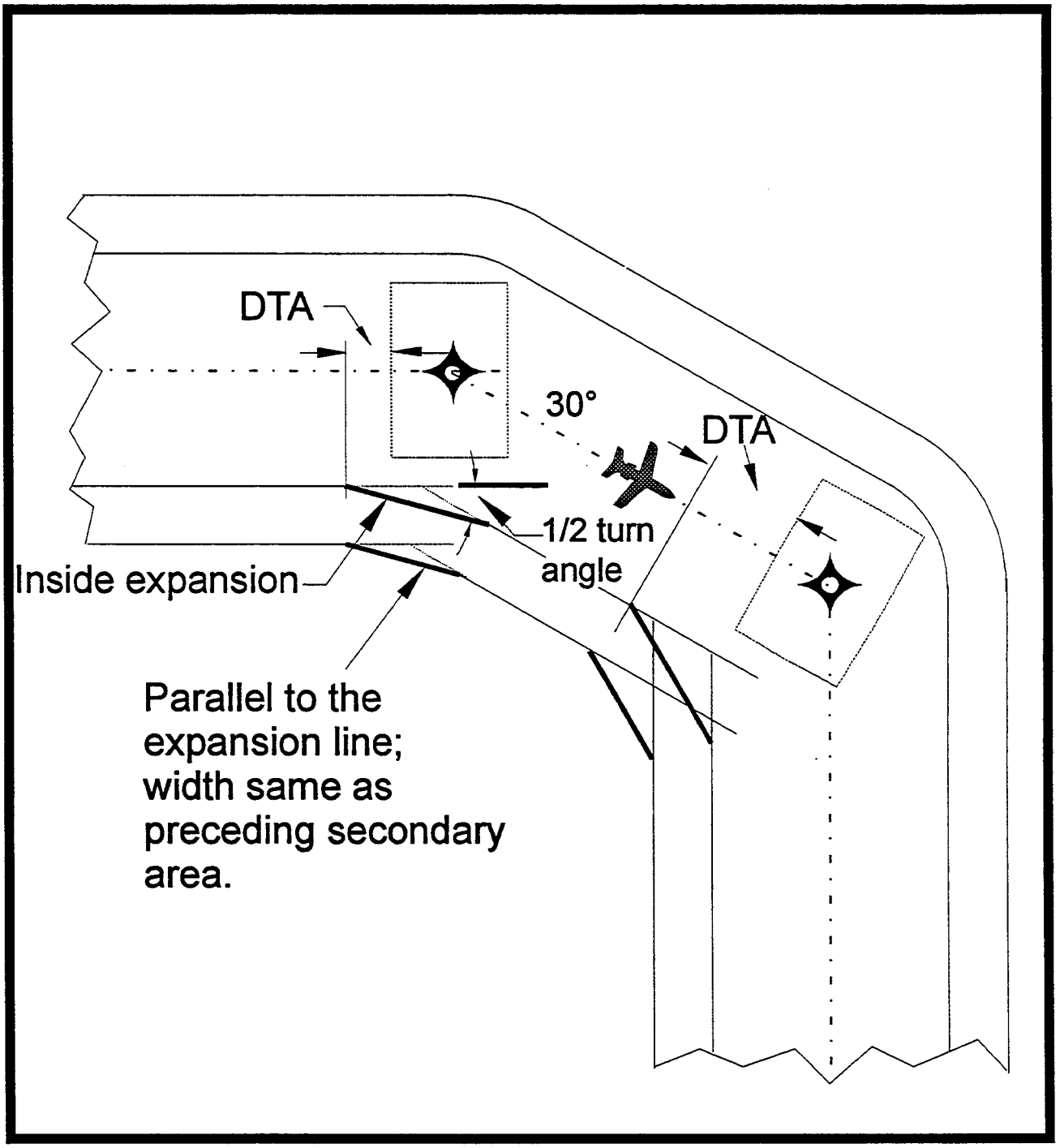


FIGURE 4. RNAV DEPARTURE, SUCCESSIVE FLY-OVER WP's, paragraph 8b.

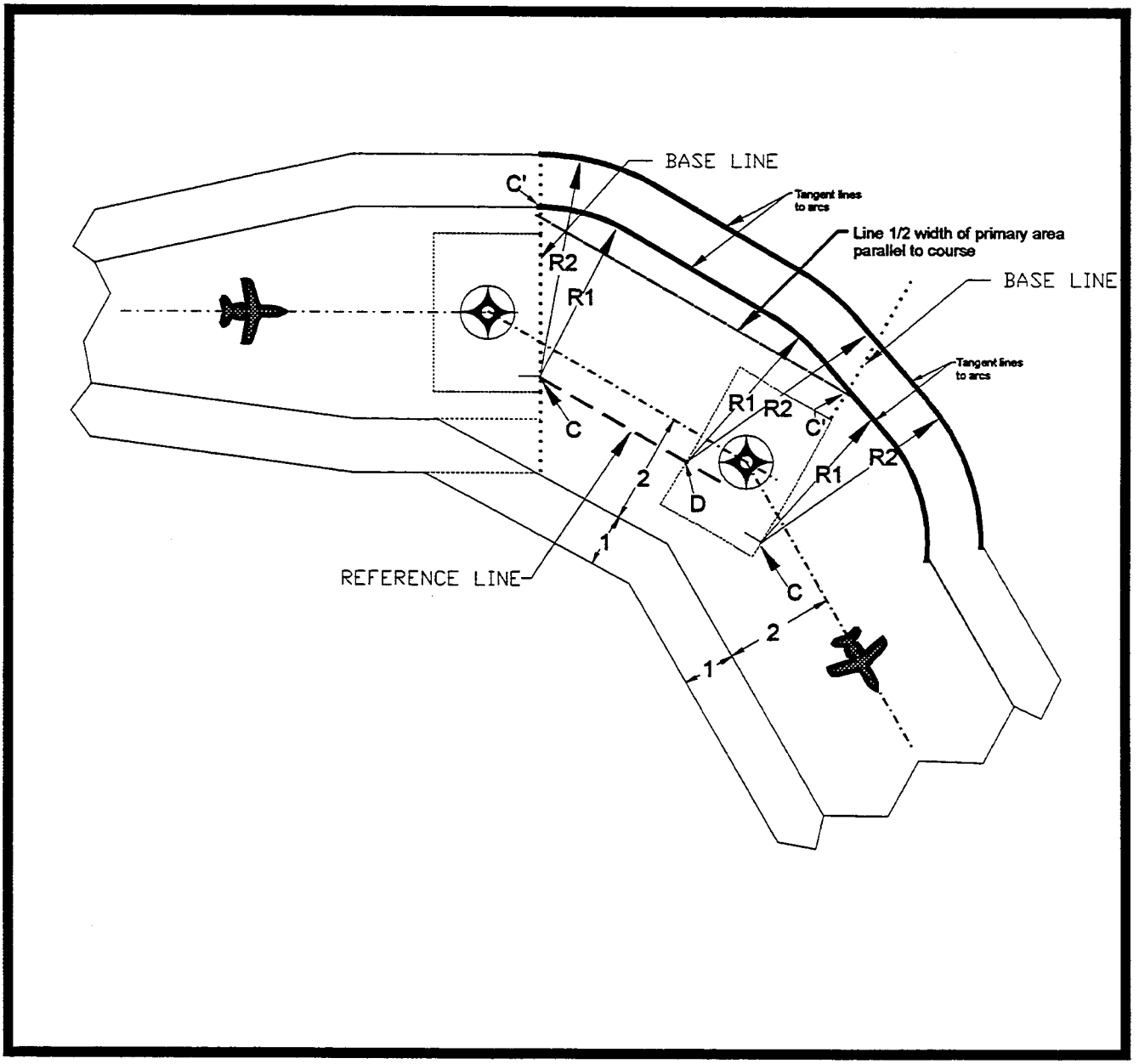


FIGURE 5. RNAV DEPARTURE, FLY-BY TO A FLY-OVER WP, paragraph 8b.

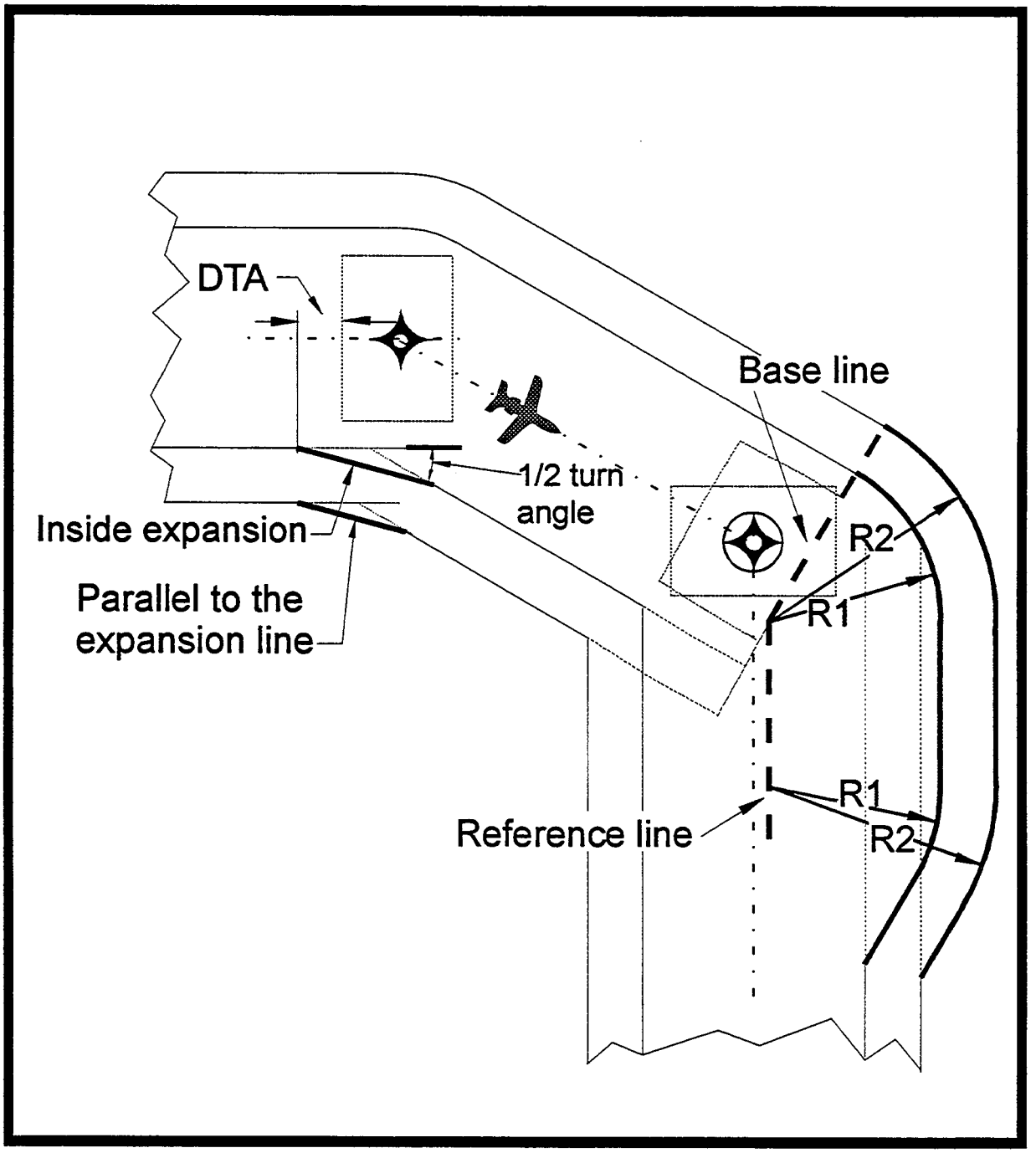


FIGURE 6. RNAV DEPARTURE, FLY-OVER TO FLY-BY WP paragraph 8b.

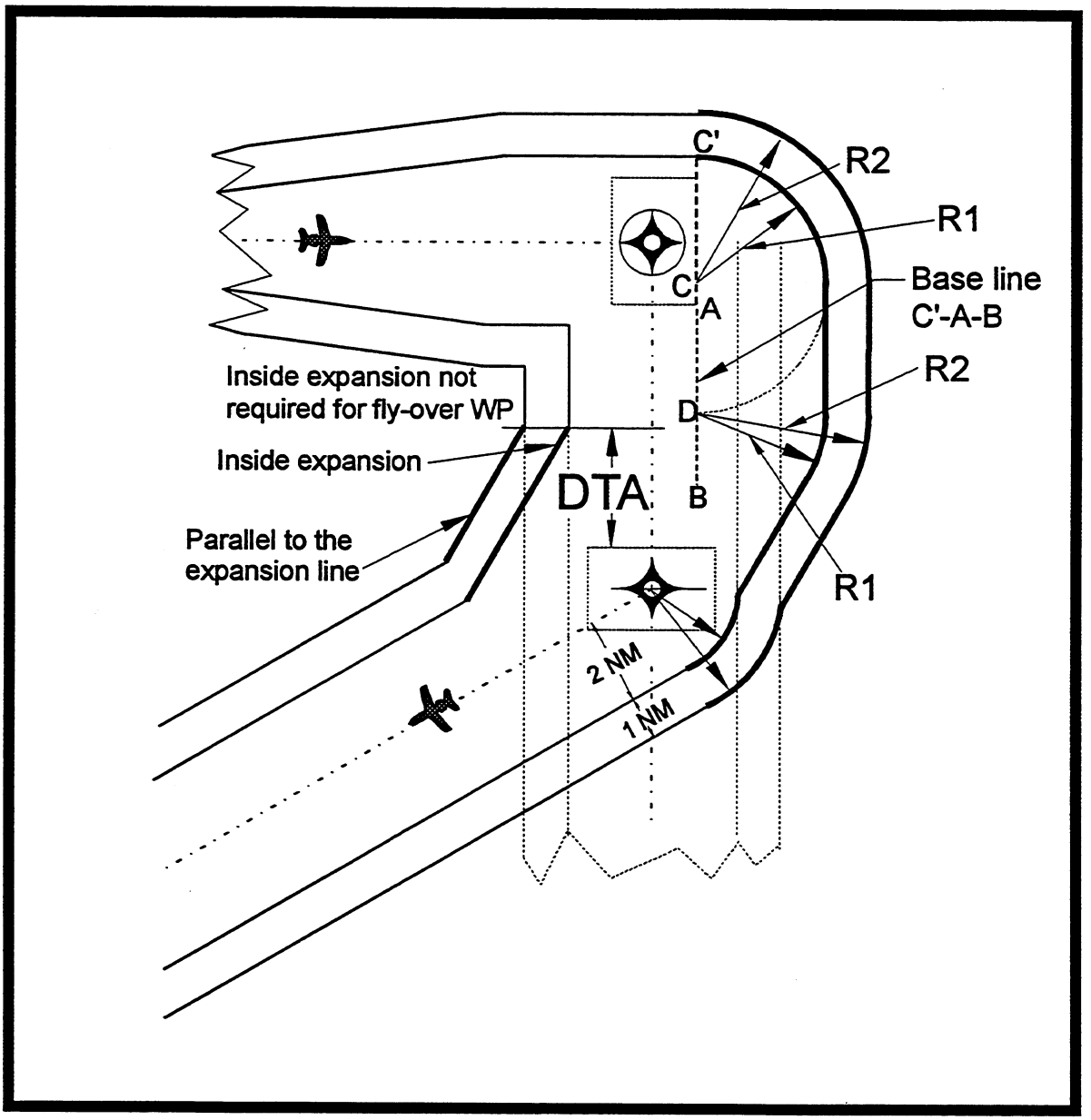


FIGURE 7. RNAV DEPARTURE, 90° TURN, FLY-OVER WP, MORE THAN 30 NM FROM ARP, paragraphs 8 and 9.

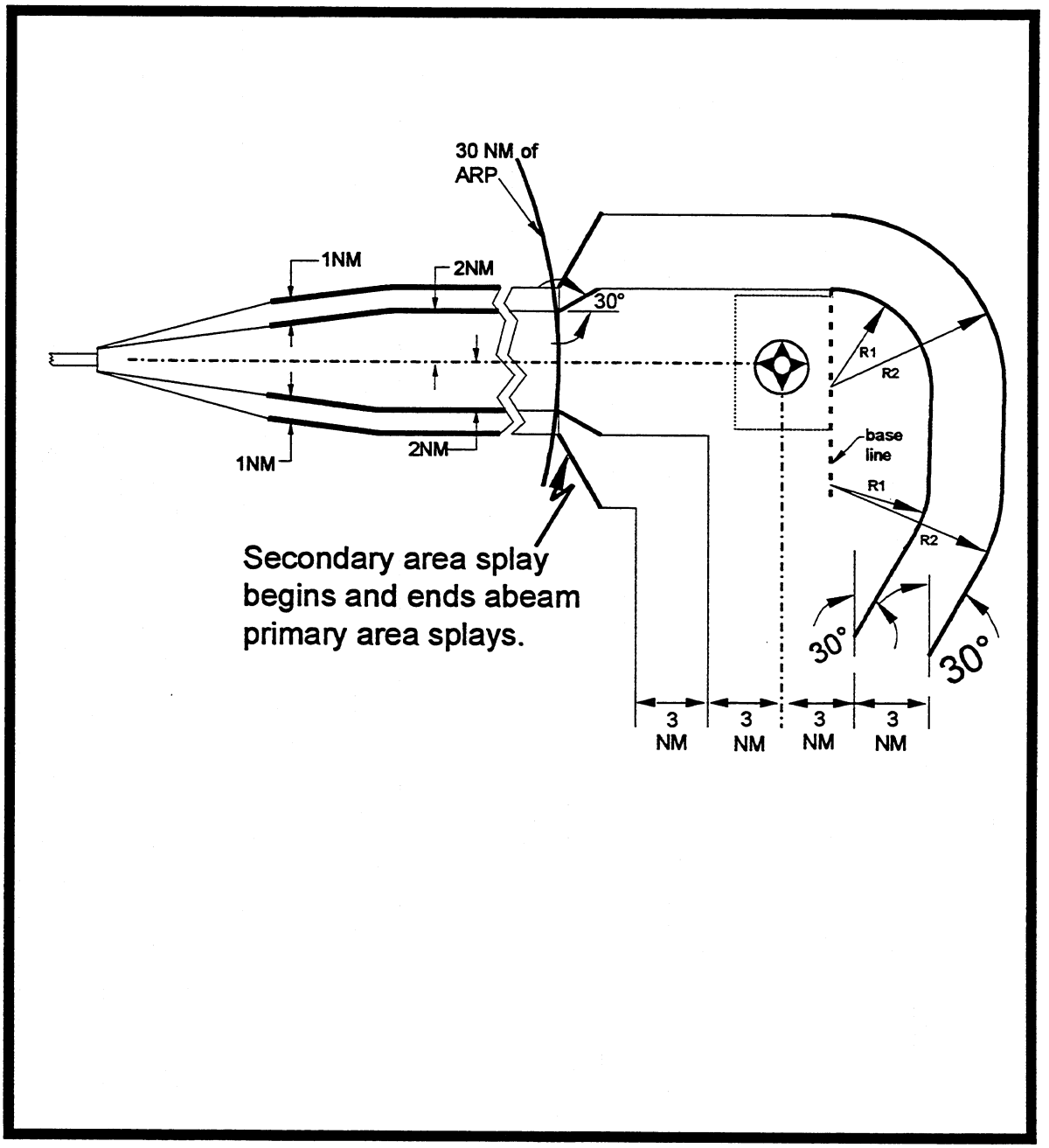


FIGURE 8. RNAV DEPARTURE, 90° OR MORE TURN, FLY-OVER WP, MORE THAN 30 NM FROM ARP, paragraphs 8 and 9.

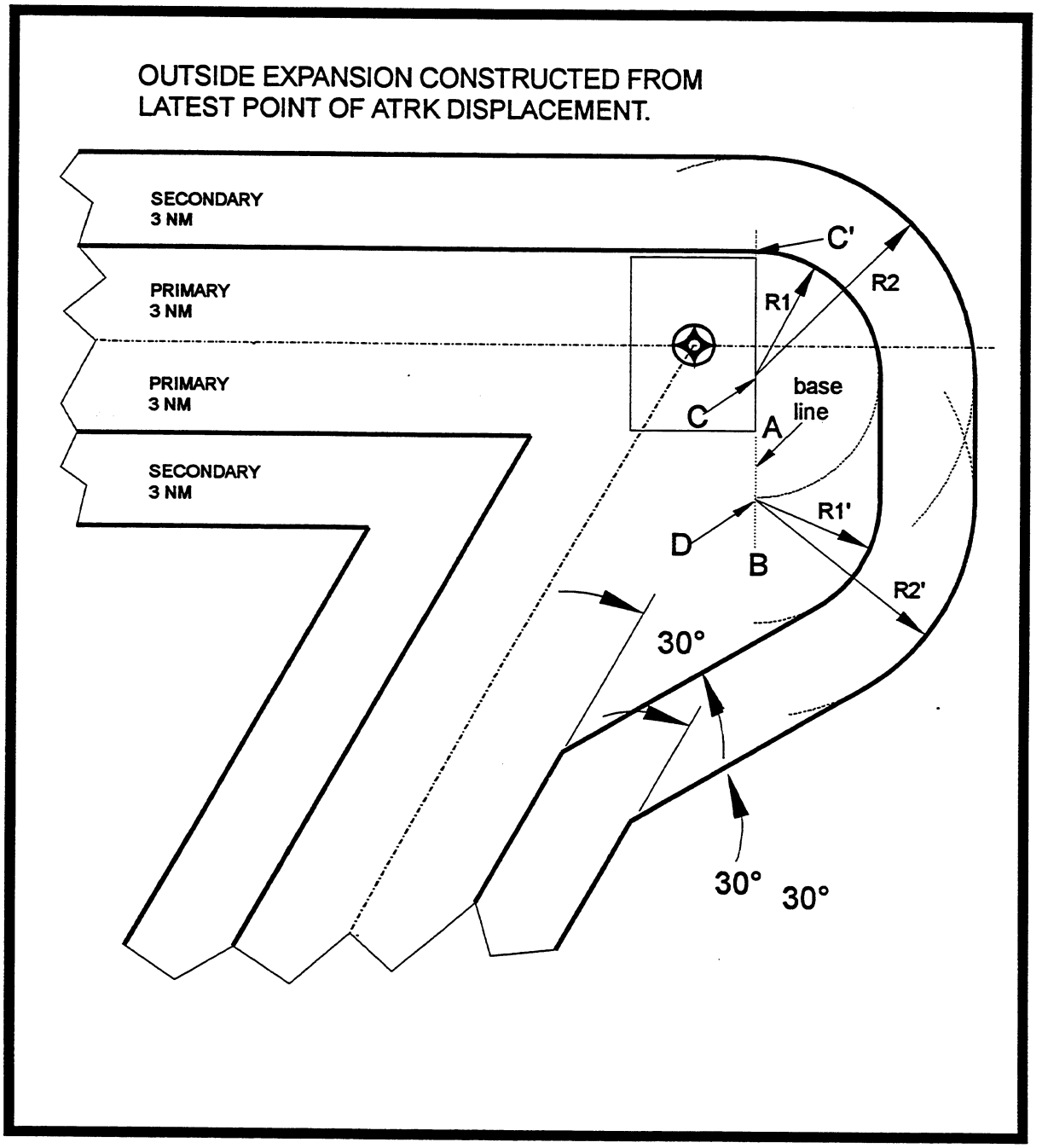


FIGURE 9. RNAV DEPARTURE, FLY-BY WP's, paragraph 8c.

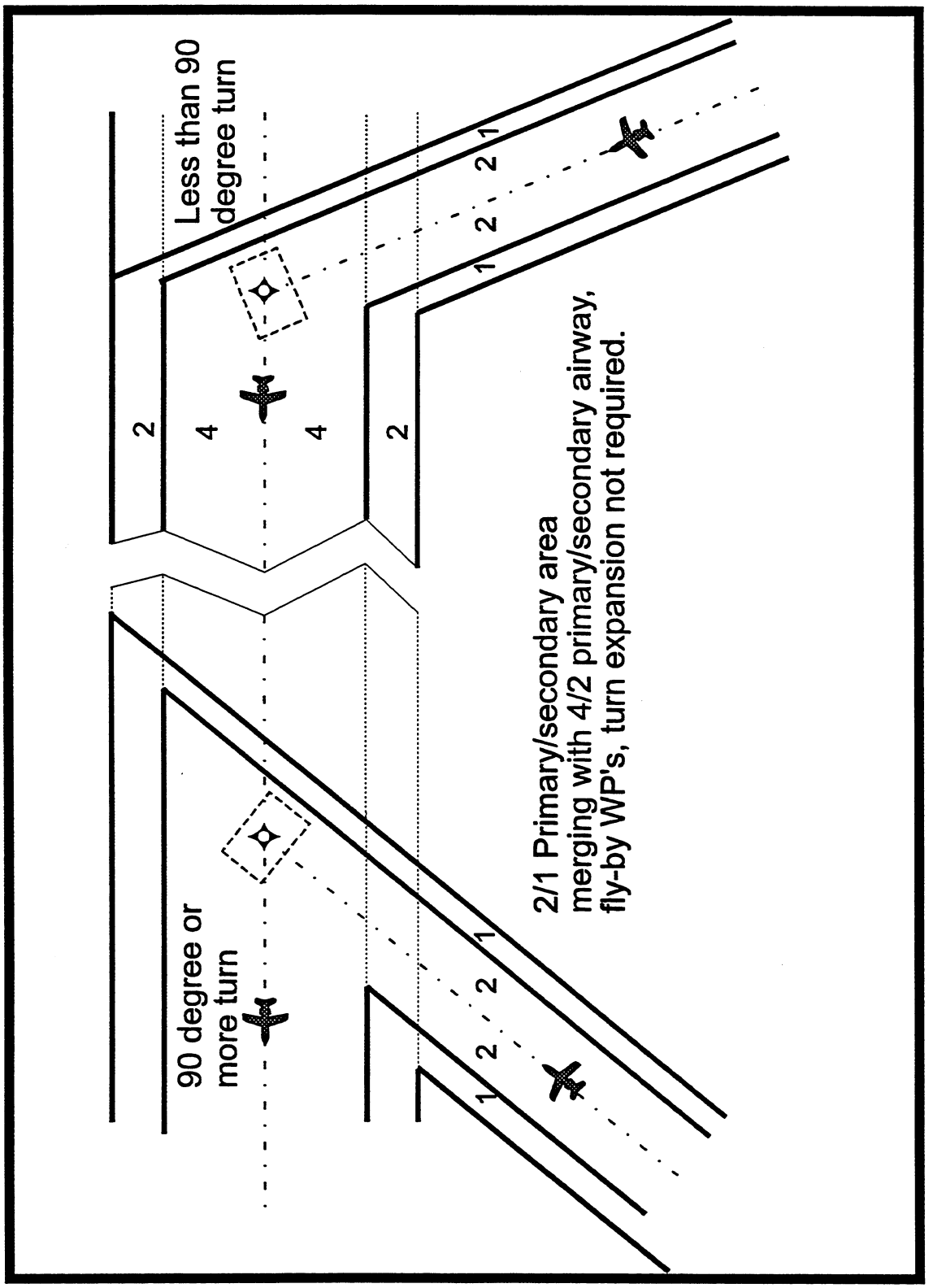


FIGURE 10. RNAV DEPARTURES, FLY-BY WP's, TURN EXPANSION REQUIRED, paragraph 8c.

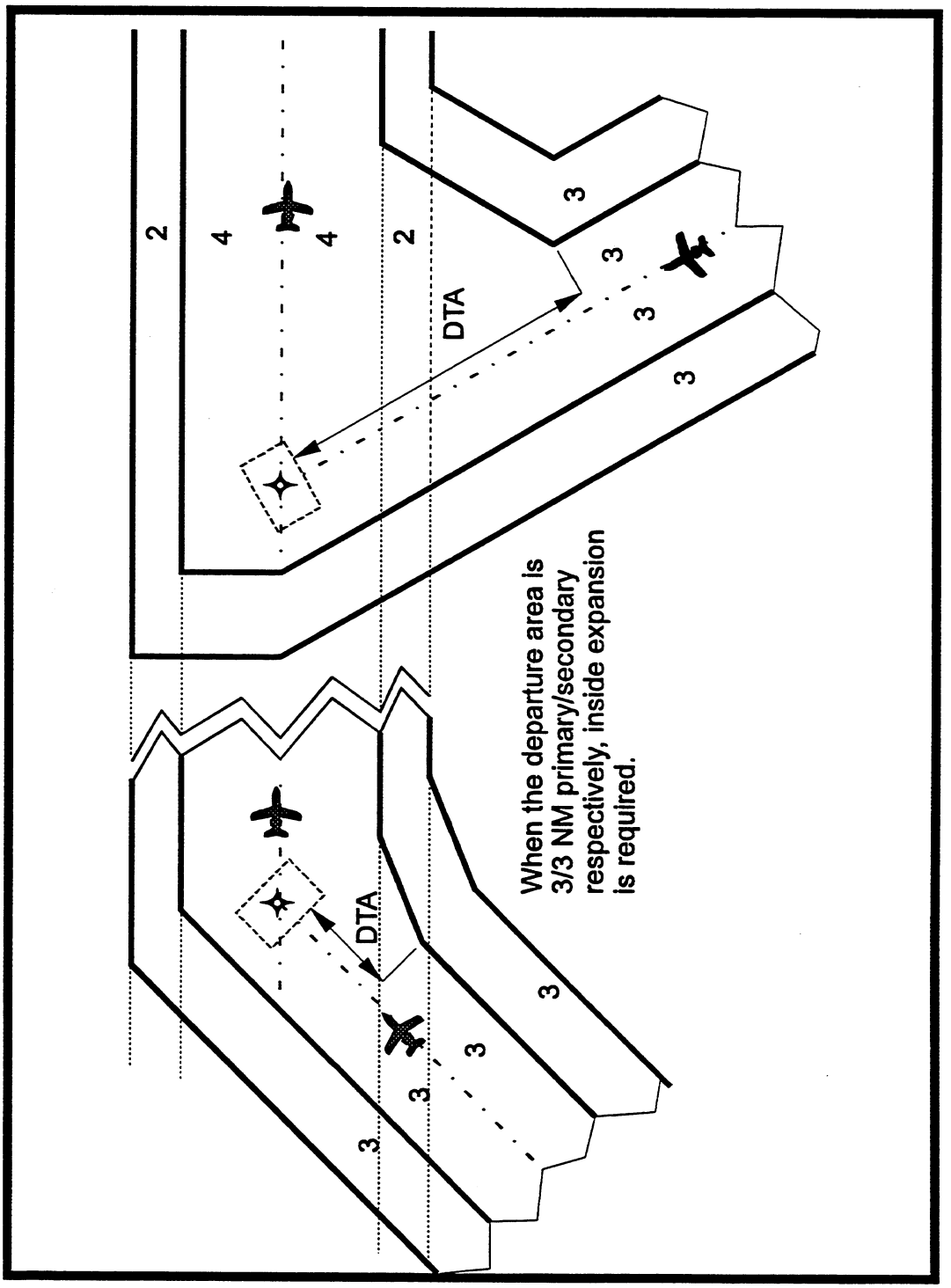


FIGURE 11. RNAV DEPARTURE JOINING EN ROUTE AIRWAY, paragraph 8c.

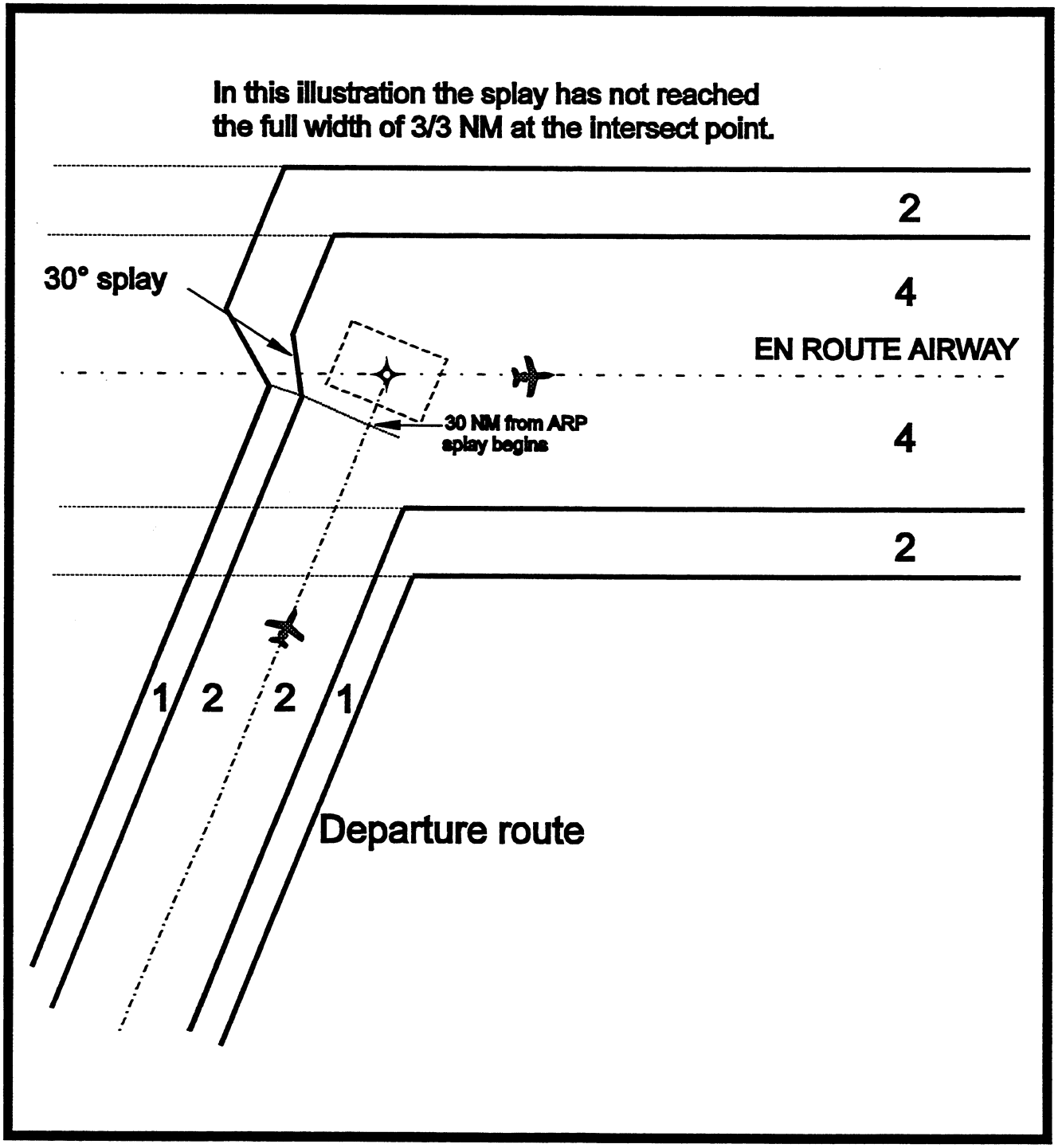


FIGURE 12. RNAV DEPARTURE JOINING AIRWAY, FLY-OVER WP, paragraph 8c.

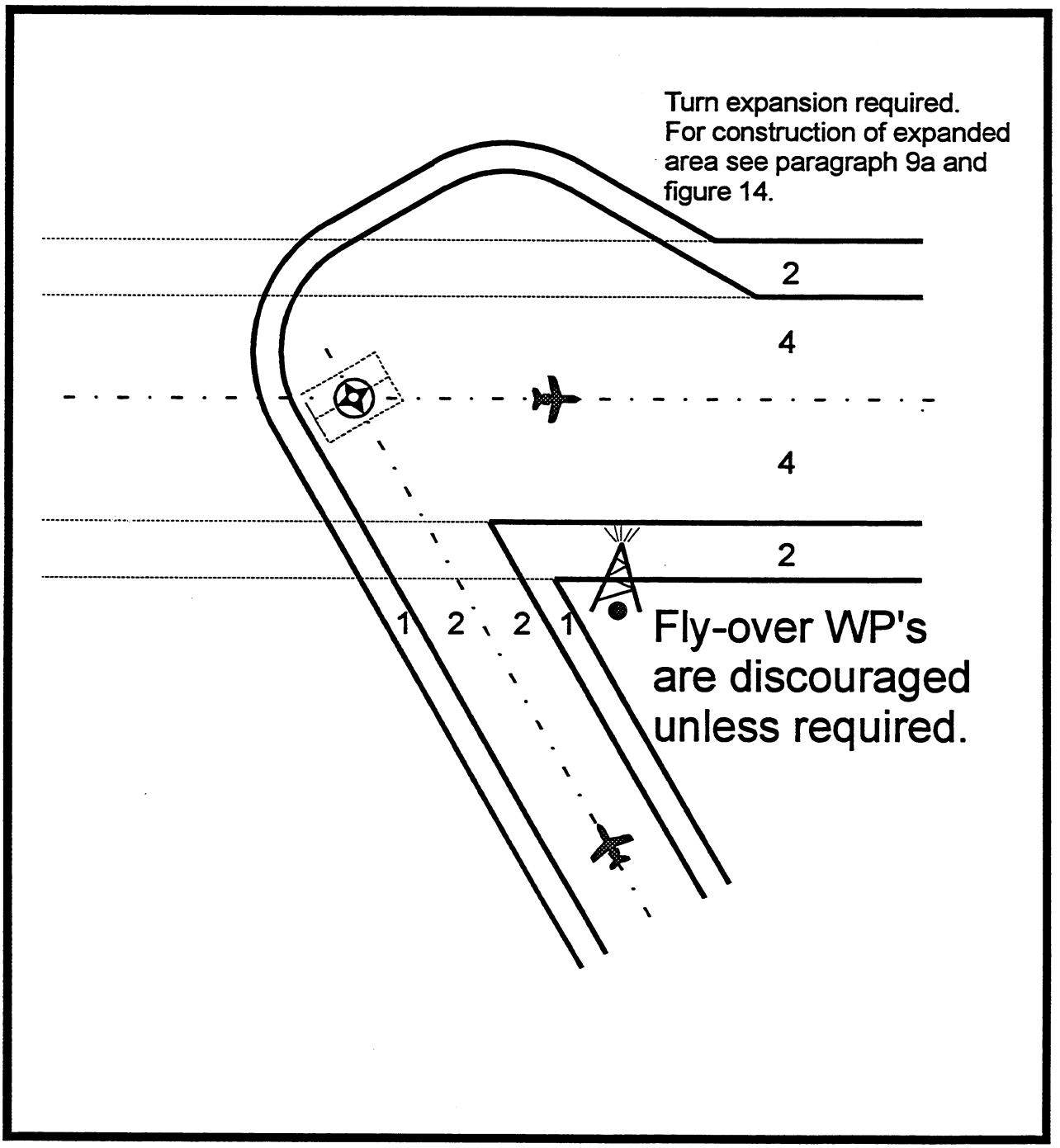


FIGURE 13. RNAV DEPARTURES, FLY-BY WP's, paragraph 9.

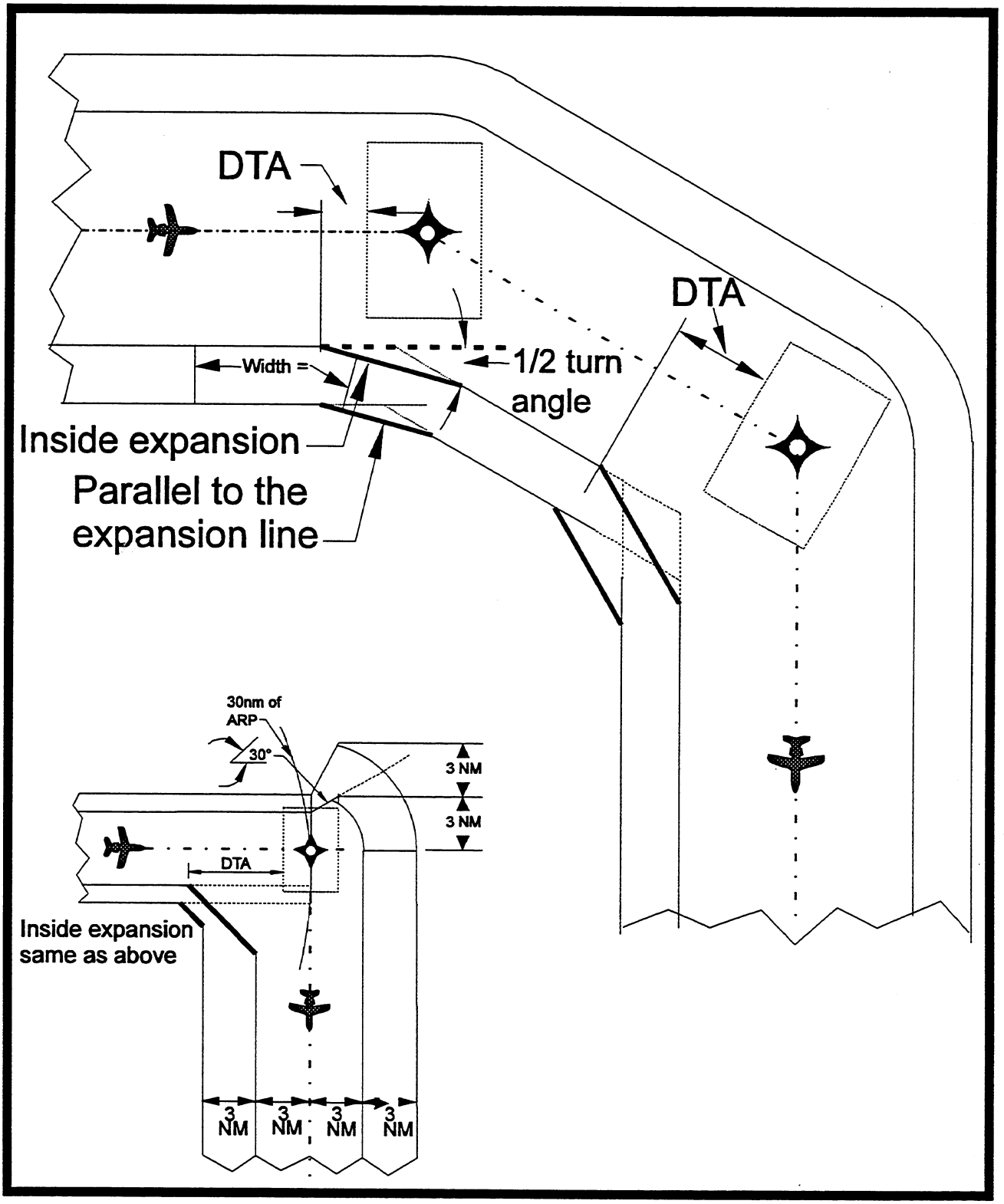


FIGURE 14. RNAV DEPARTURE, HANDLING OF DTA IN SPLAY AREA, paragraph 9.

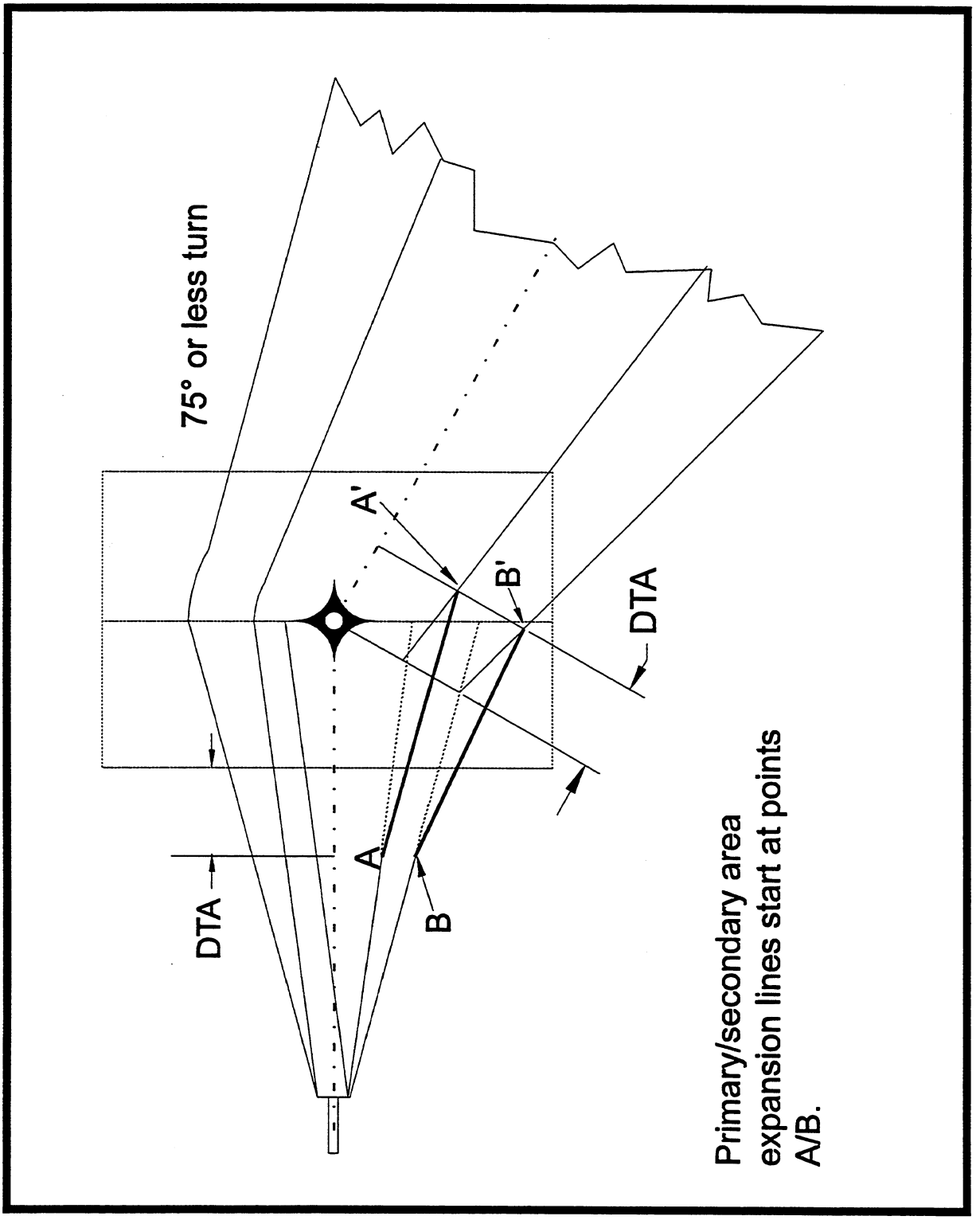


FIGURE 15. RNAV DEPARTURE, FLY-BY WP, paragraph 9.

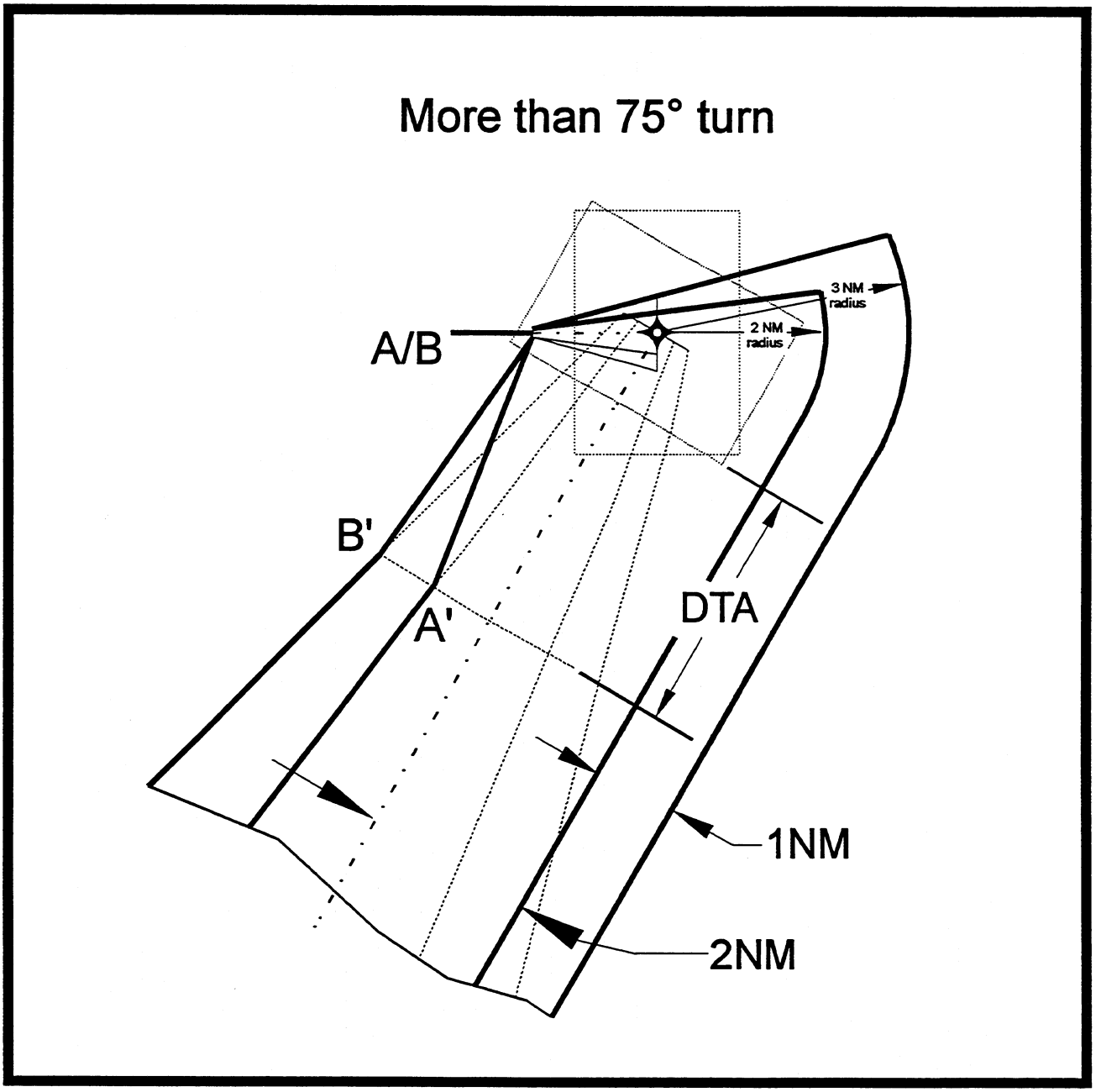


FIGURE 16. RNAV DEPARTURE, FLY-OVER WP, paragraph 9.

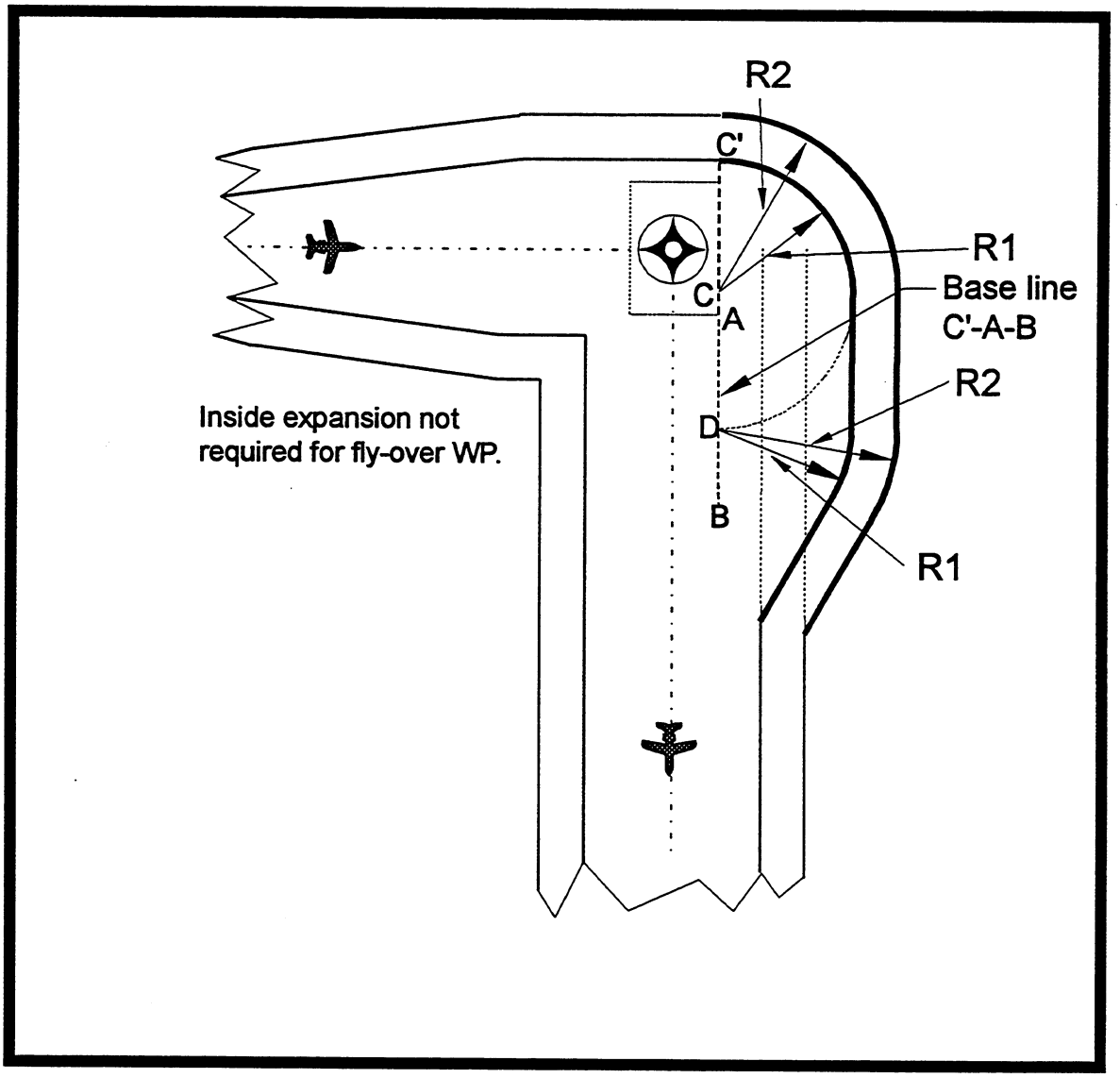


FIGURE 17. RNAV DEPARTURE, 90° OR MORE TURN, FLY-OVER WP, 1 NM FROM DER, paragraph 9.

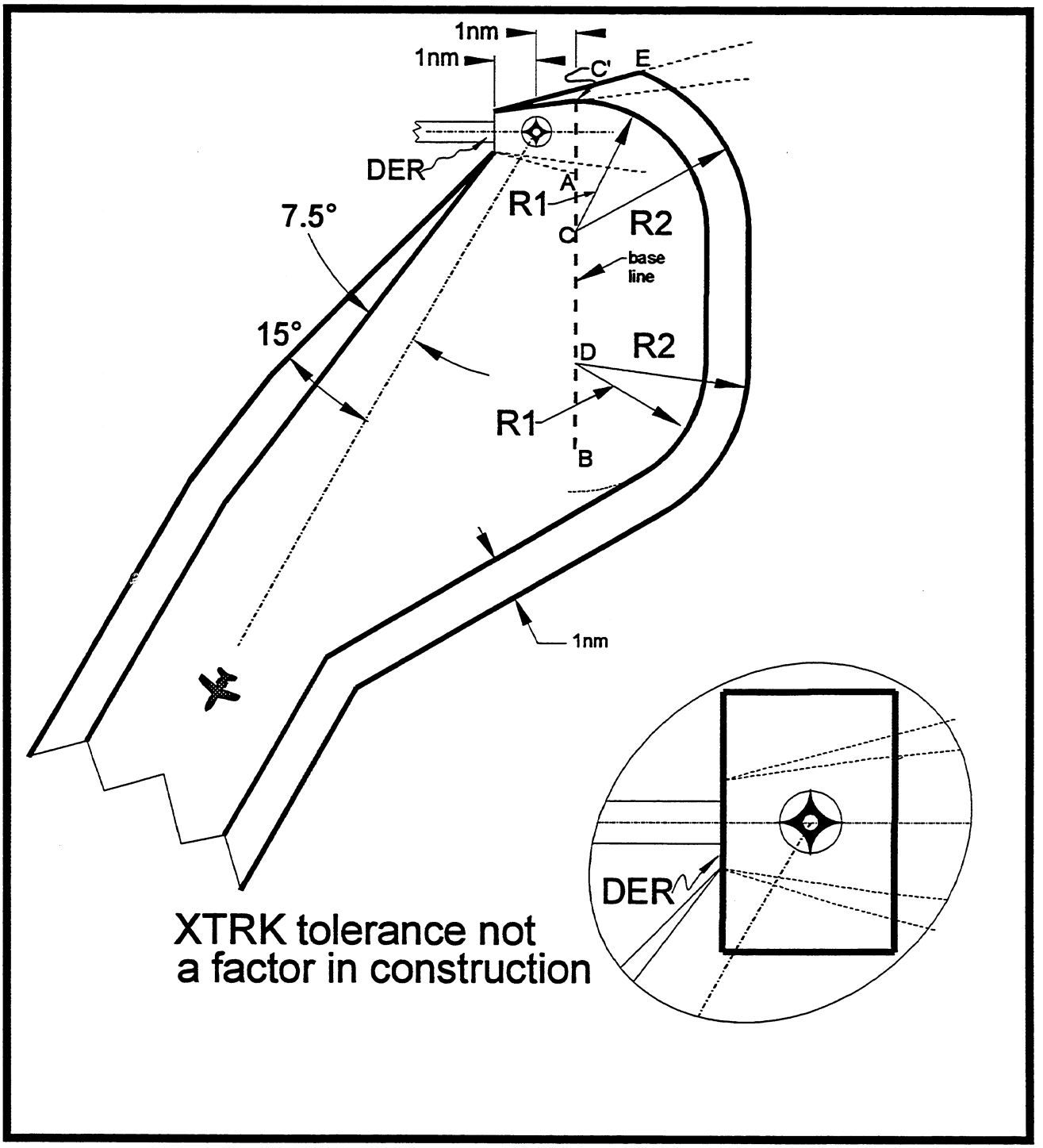


FIGURE 18. RNAV DEPARTURE, FLY-OVER WP.

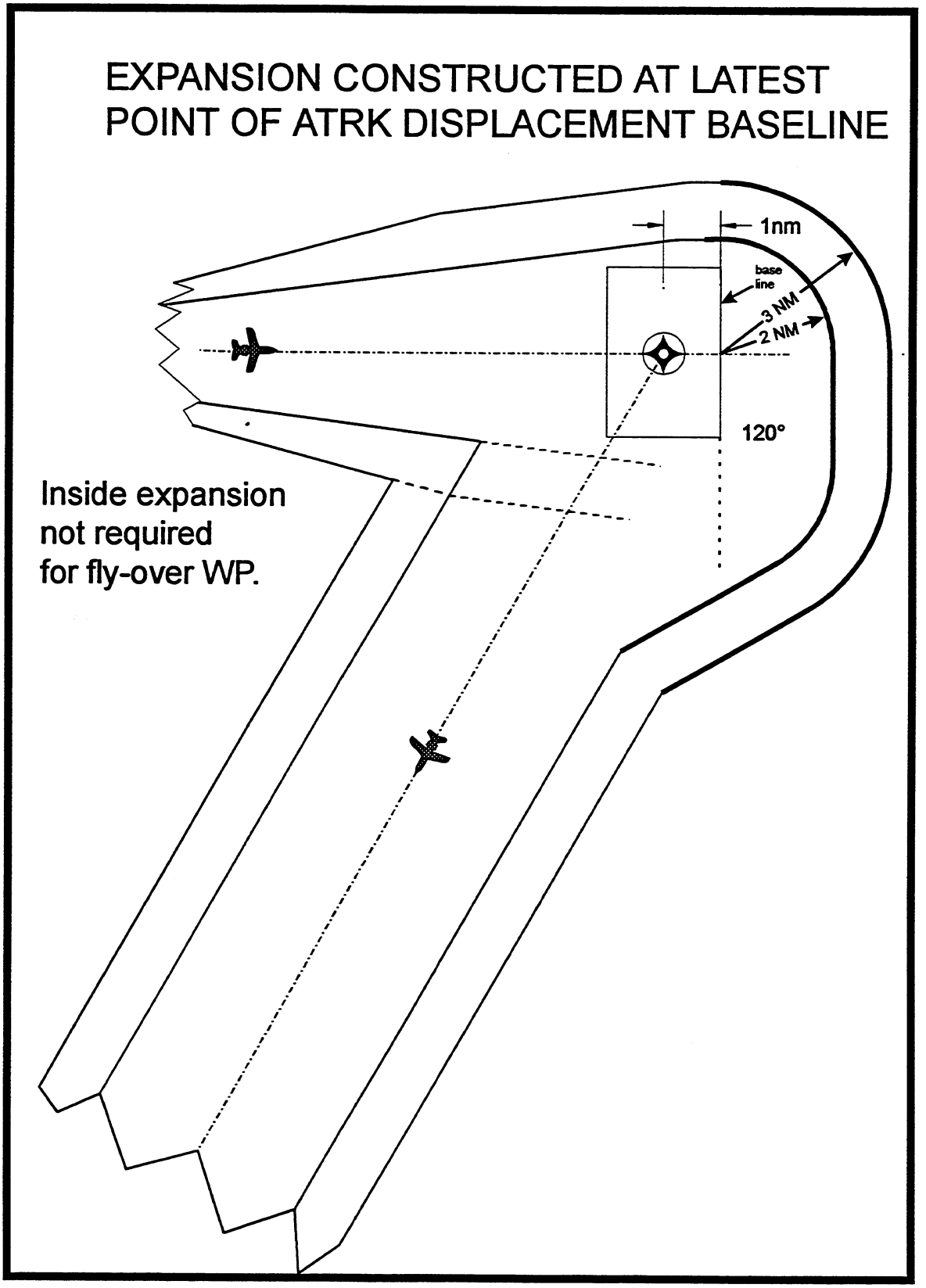


FIGURE 19. RNAV DEPARTURE, EVALUATION OF OBSTACLES, paragraph 11.

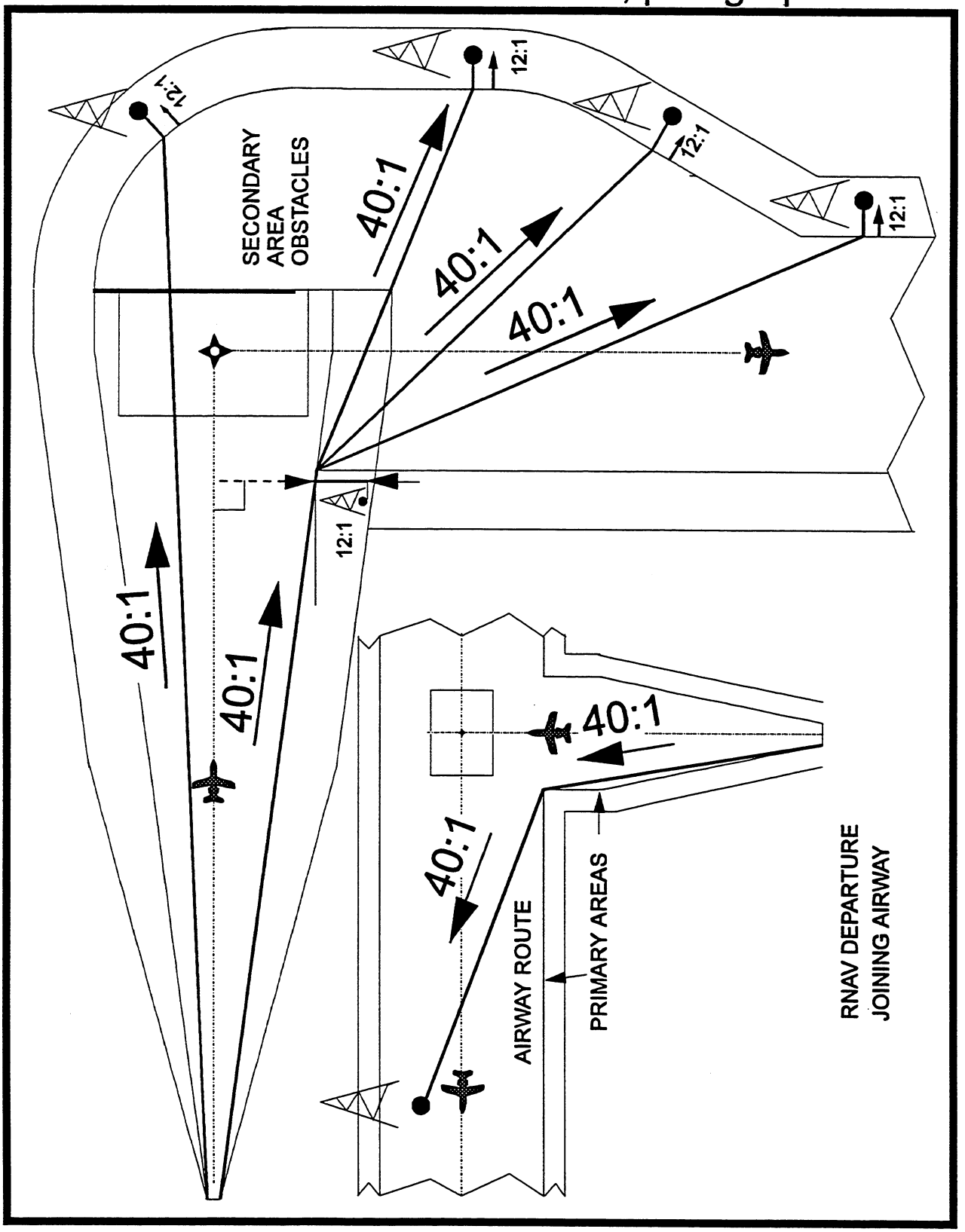
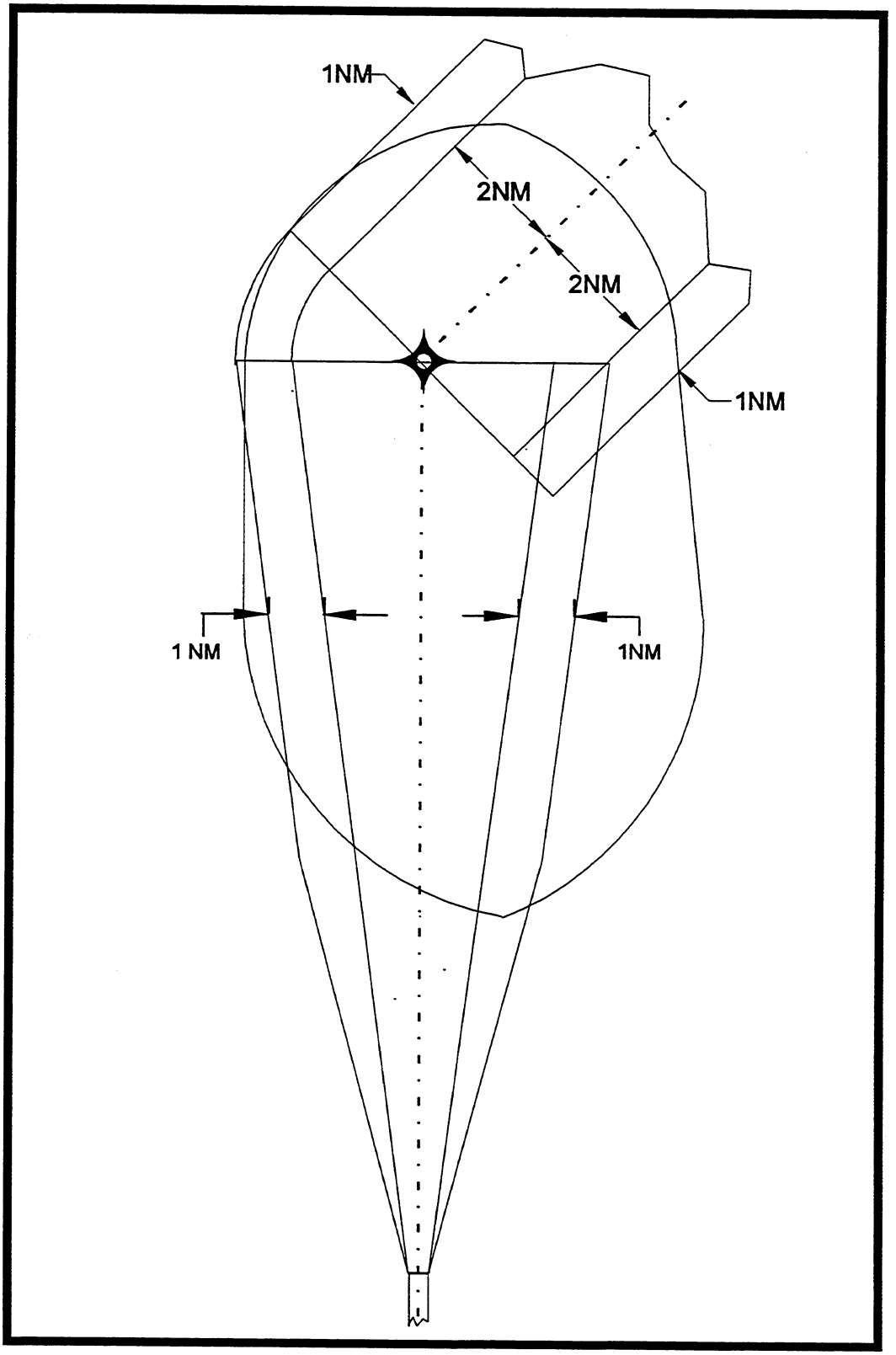


FIGURE 20. RNAV DEPARTURE, CLIMB IN-HOLD, paragraph 13.



U.S. Department
of Transportation

**Federal Aviation
Administration**

Directive Feedback Information

Please submit any written comments or recommendations for improving this directive, or suggest new items or subjects to be added to it. Also, if you find an error, please tell us about it.

Subject: Order _____

To: Directive Management Officer, _____

(Please check all appropriate line items)

☐ An error (procedural or typographical) has been noted in paragraph _____ on page _____.

☐ Recommend paragraph _____ on page _____ be changed as follows:
(attach separate sheet if necessary)

☐ In a future change to this directive, please include coverage on the folowing subject
(briefly describe what you want added):

☐ Other comments:

☐ I would like to discuss the above. Please contact me.

Submitted by: _____ Date: _____

FTS Telephone Number: _____ Routing Symbol: _____

FAA Form 1320—19 (8-89)